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ANNALS *of* SURGERY

Vol. XCVI DECEMBER, 1932 No. 6

THE FISSURES OF THE LUNGS*

By Frank B. Berry, M.D. and Edward P. Childs, M.D.

of New York, N.Y.

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Up to the present time few, if any, adequate anatomical studies have been made of the interlobar fissures of the lungs. It is our purpose, therefore, to outline briefly a method which has such clinical and exact anatomical advantages as to be decidedly worthy of further pursuit. Several excellent articles have appeared but heretofore all have stopped just short of completion. The authors have written either from the clinico-pathological or Röntgen-ray aspects and in some instances have given excellent anatomical descriptions of the fissures. In only one instance, however—the work of Sampson, Heise, and Brown—has any study been attempted on the cadaver itself with radio-opaque substances to determine the normal and simulated abnormal anatomy by a combination of the ordinary methods of dissection and the use of the X-ray.

History.—Luschka first described the anatomy of the interlobar fissures. "A noteworthy characteristic of the coarse configuration of the lungs is based on their external separation into large interdependent portions, the lobes or wings—lobi pulmonales. These are formed by fissures—incisuræ interlobulares—penetrating more or less deeply, sometimes to the vicinity of the root of the lung, with smooth and normally closely approximating surfaces and even, sharpened edges. In each lung, correspondingly, is a large diagonal incision, beginning at the back in the vicinity of the vertebral end of the third rib and extending through almost the entire thickness diagonally, left to the medial end of the sixth rib and right, farther outward from this locality. One may therefore conclude that the apex belongs entirely to the upper lobe and that the anterior circumference is preferably formed by the upper lobe and the posterior by the lower. As a rule only one incision is found in the left lung, while in the right is a second, shorter one, proceeding horizontally at the level of the sternal end of the fifth rib and joining the oblique fissure back of the axillary line. Thus under ordinary conditions we find the right lung divided into three lobes (upper, middle and lower) and the left into two (upper and lower), although as regards the two sides, they correspond in size and shape." Since then later authors have described variations in the arrangement of the fissures.

Laennec was the first to note the involvement of the fissures in disease. He states that encapsulated or circumscribed pleurisies occur in three places most commonly: (1) the fissures; (2) the base of the pleural cavities and on the diaphragm, and (3) in the post-inferior or lateral portion of the chest. He then describes the pathology of interlobar pleurisy at some length. In the latter quarter of the nineteenth century considerable attention was given to their pathology by the French under the leadership of Dieulafoy, who first mentions interlobar collections in 1872, again in his Manuel de Pathologie Interne in 1882, and again in his article on Interlobar Pleurisy in 1899. But exudates, cysts, and neoplasms located in the fissures are extremely difficult to diagnose when reliance must be placed solely on often obscure or entirely absent physical signs.

*Read before the New York Surgical Society, November 25, 1931.

Hence, it was not until the advent of the X-ray that any general impetus was given to their study.

Even today, with the aid of the röntgenogram, pathology of the interlobar fissures still remains hidden and difficult of diagnosis and localization. This

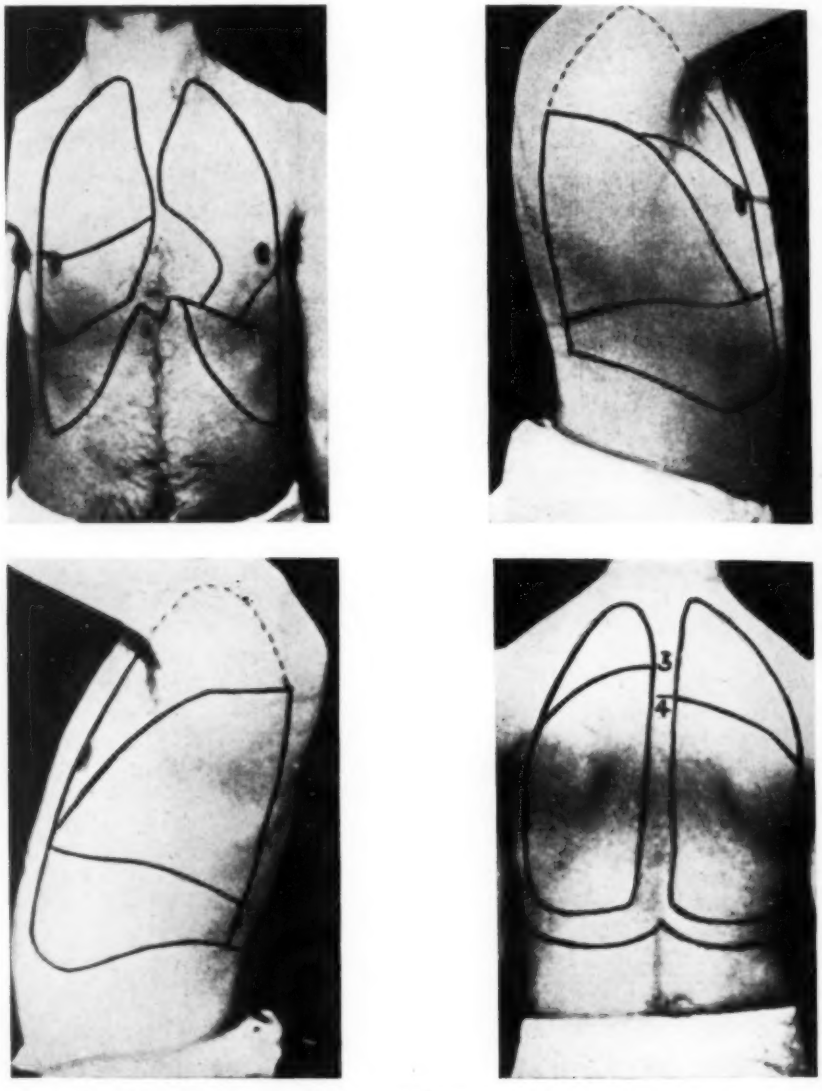

FIG. 1.—Interlobar fissures as marked upon the chest-wall of the normal adult. (From Sampson, Heise and Brown: Am. Rev. of Tuberculosis, vol. ii.)

is due, no doubt, in part, to a haziness in the minds of many clinicians and radiologists as to the exact location and extent of the fissures. Also, there is a failure on the part of many to comprehend the possibility of disease here. Impressed by these difficulties, we have sought to find some means of lessening and clarifying them.

Normal Anatomy.—For any adequate understanding of the normal anatomy one must, above all else, consider and visualize the interlobar fissures as a series of concavo-convex surfaces meeting about the hilus. In addition, the surfaces of the great fissures are twisted upon themselves so that they form a propeller-like figure, with the upper oval surface facing forward and slightly laterally, and the lower half facing forward and somewhat medially.

The main fissures are given as commencing posteriorly at a varying level between the second and third thoracic spines, or third or fourth thoracic vertebræ. On the left the line begins at the posterior margin of the medial surface of the lung and runs back and up to the posterior surface, where it arches slightly up over the posterior convexity and then runs downward to the level of the sixth costal cartilage, cutting the lung just above the cardiac incisure. It crosses the fourth interspace in the mid-axillary line.

FIG. 2.—Configuration of the main fissures. (After Dietlen.)

The right fissure starts a little lower, usually at the neck of the fourth rib, and its arch across the posterior surface of the lung is even more gradual than on the left; hence, its descent through the axilla is less steep. In the mid-axillary line it crosses the fifth rib. The diaphragm is reached at a varying point from the mid-axillary line to the sixth costochondral junction. Beginning just anterior to the posterior axillary line in the fourth interspace, the small transverse fissure runs almost horizontally to a varying point beneath the fourth costal cartilage, or even all the way to the anterior border of the lung. It has usually a slight upward convexity but may vary in either direction from the absolute horizontal. The depth and extent of this fissure are notably inconstant, however, so that the middle lobe is frequently merely a divided portion of the upper.

Visualization of the deep course of the fissures is difficult and it is hard to realize that they extend to the primary bronchi. Thus the two main fissures divide the lungs into almost equal parts. Although the two main fissures are much more constant than the transverse in their course, still, occasionally, they do not always extend to the mediastinum. Consequently, the upper and lower, or upper, middle, and lower lobes may be more or less interconnected by lung tissue.

On the right the large fissure runs across the phrenic surface of the lung in an oblique medio-dorsal direction. This surface is thus divided into a small antero-medial portion—about one-quarter to one-third of the entire area—belonging to the middle lobe and a large posterior portion belonging to the

lower lobe. At the medial lower border of the lung the fissure extends to the mediastinal surface, ascending almost vertically to the hilum. Thence it ascends steeply posteriorly to the root of the third rib, where it again meets the costal surface of the lung.

The left fissure extends from the lower border of the lungs to the phrenic surface and proceeds similarly to the right. Because the basal pulmonary surface is so interfered with by the heart, only a narrow strip of the upper lobe participates in the phrenic surface. On the mediastinal surface, the course of the fissure approximates that on the right but is somewhat less steep. Both main fissures form a 45-degree angle with the diaphragm.

As already mentioned, these fissures, even normally, may vary appreciably in number and extent, and also, though less constantly, in position. Rochard,

FIG. 3.—Experimental. Lead foil in left fissure. A-P view.

FIG. 4.—Same as Fig. 3. Lateral view.

in studying empyema in relation to the interlobar fissures, examined twelve cadavers. In these he found that the location of the main right fissure varied posteriorly from the second to seventh ribs and anteriorly from the fifth to seventh interspaces. The transverse fissure began from the fourth to seventh ribs posteriorly and ended from the third space to the sixth rib anteriorly. On the left the start of the fissure varied from outside the costochondral junctions to beneath the sternum itself. In one instance the upper and lower lobes on the right were undivided. To those familiar with surgery of the lungs and pleura these variations are not surprising.

The above describes merely the normal anatomy with the common anomalies and variations. It must be constantly borne in mind that all of this is altered in the presence of existing skeletal deformities or with coëxisting pathology of adjacent viscera or spaces such as the heart and pericardium,

the liver, the thyroid, the mediastinum and its glands, or subphrenic collections. Also, recent or old pathology in the lungs or pleura themselves may completely change or destroy the normal position, extent, and relation of the fissures.

Experiment.—The great assistance and yet the shortcomings of the X-ray and its interpretation cannot but impress any one who is faced with these problems with any degree of frequency. This failure of exact localization has been demonstrated at operation or autopsy. At best the radiological search, both by fluoroscopy and films, as it should always be, is tedious and exhausting both to patient and examiner. Excellent articles have been written and methods of examinations detailed. But still there seemed room for improvement. First, could not some method be devised whereby, with the

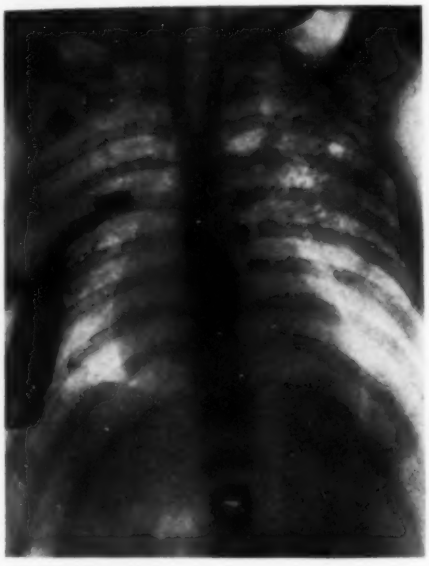

FIG. 5.—Lead foil in right fissure. A-P view. Note incompleteness of transverse fissure.

FIG. 6.—Same as Fig. 5. Lateral view.

use of radio-opaque substances, the fissures might be completely outlined in the human? Second, with this *a fait accompli*, could we not then, in like manner, simulate focal collections in the fissures *ad lib.* and study them röntgenologically? Thus X-ray films could be made and studied in which the anatomy of the fissures could be definitely and positively seen. This conception is simple enough but its fulfillment is beset with major difficulties of a very practical sort. Fresh subjects must be employed and adequate X-ray studies must be made as expeditiously as possible. We are virtually limited to that small group in which necropsy permission is granted. Furthermore, the pathologist and radiologist must complement each other. This is not easy to attain in our present hospital organization.

Due to the great kindness and sympathetic understanding of one of our pathologists and with the assistance of an expert technician this was made

possible to a limited extent. A portable X-ray outfit was used. With our small equipment only antero-postero and lateral exposures were attainable. The only materials used were a thin lead foil, "brillo," 50 per cent. mercurial ointment, and rubber balloons filled with 50 per cent. sodium iodide solution. The usual median sternal autopsy incision was made. The sternum was left attached at the sterno-clavicular articulations but otherwise freed by cutting through each costal cartilage and the muscular attachments; it was then folded back. Exploration of the pleural cavities and fissures was then made. If adhesions were present, these were carefully loosened as far as possible. The lungs were inflated and the trachea ligated *in situ*. First, the fissures were defined by inserting into each, throughout its entire extent, a thin sheet of lead foil so as just to fill the fissure, if possible. The sternum was replaced,

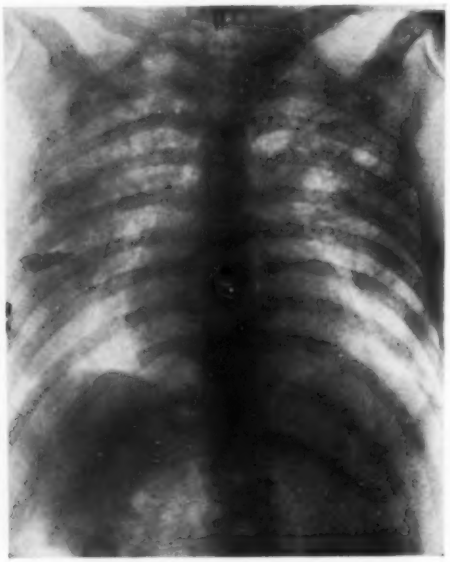

FIG. 7.—Transverse fissure alone. A-P view.

FIG. 8.—Same as Fig. 7. Lateral view.

the skin loosely sutured, and X-rays made. After this series was completed, similar studies were made with small or large rubber bags filled with 50 per cent. iodide solution, "brillo," or mercurial ointment. These little sacs were placed in the fissures at known points. Only rarely did they slip or change position during the procedure.

From an examination of the films several facts are at once evident. First, even the flat film of the left great fissure demonstrates very well the rotation of the surfaces on each other. Two-thirds of the way down the foil is bent upon itself and a double or oblique denser shadow is cast by its outer portion. Second, from the simple antero-postero film no inkling whatsoever is given that the opaque substances are in the great fissures. The same would apply to a postero-antero film. Only when the respective lateral films are studied is this brought out or suspected, for only then does the position in the sagittal plane become apparent. Third, the transverse fissure,

although very variable in extent, gives a characteristic shadow. Shadows here, therefore, are easier of localization than in the great fissures.

FIG. 9.—Balloon of sodium iodide in left fissure near axilla at third and fourth ribs.

FIG. 10.—Same as Fig. 9. Lateral view.

These studies are all too brief and sketchy. It is hoped that they may be elaborated, that oblique and stereoscopic films may be made and also

FIG. 11.—Two balloons with opaque mixture in right main fissure.

FIG. 12.—Same as Fig. 11. Lateral view.

the position of the tube varied. They merely point out a field for future work, once a sufficient organization can be perfected.

ILLUSTRATIVE CASES.—As illustrative of this work I wish to present the following cases, each verified by operation.

CASE I.—B. H., 8742, J. S., male, aged nineteen. *Family History.*—Irrelevant. *Past History.*—Important only in that in 1918 he had a tonsillectomy. This was followed by pneumonia and empyema on the right for which he was operated. He has been well since, until recently, when he began to have pain in his right lower chest in the posterior axillary region. This is aggravated on coughing. He says that for a short time one year ago, he had similar pain there.

Physical Examination.—Physical examination shows a tall, well-developed young man, not appearing very ill. Physical findings are: There is an old scar over the ninth rib in the right posterior axilla with some tenderness about the scar. There is dullness over the base of the right lung posteriorly and diminution of breath sounds here, in the axilla, and over the middle lobe anteriorly. The heart apex is just outside the left nipple line. Physical examination was otherwise negative. Temperature, 99.4°; pulse,

FIG. 13.—(Case I.) A-P view. Small exudate present in fissure.

FIG. 14.—(Case I.) Lateral view.

84; white blood-count, 9600; 72 per cent. polymorphonuclears. X-ray showed an interlobar plastic pleurisy between the upper and middle lobes on the right, and an irregular consolidation of the right middle lobe.

Operation.—A diagnosis was made of a sacculated interlobar empyema. The axillary portions of the fourth and fifth ribs on the right were resected for a distance of five centimetres. The pleura was opened along the bed of the fifth rib. The interlobar fissure was found and the lung was adherent to the pleura by delicate adhesions. A round cavity three centimetres in diameter was found in the transverse fissure between the upper and middle lobes. There seemed to be a small bronchial fistula and cavity containing a small amount of pus.

Course.—Following operation a mild pleurisy developed on the same side. Following the subsidence of this the patient made a slow but uneventful recovery, and was discharged, healed, on the thirty-fifth day post-operative and has been well since for the past four months.

CASE II.—B. H. 17349, L. F., female, aged thirty-six. *Family History.*—Irrelevant. *Past History.*—Onset of illness November, 1929, with slight cough. One month later,

patient coughed up several mouthfuls of blood; in April, 1930, was confined to bed with what was considered a lobar pneumonia of the right lower lobe. Since then she has continued to cough up about one-half cupful of slightly foul mucopurulent sputum daily, and she has lost about twenty pounds. Also in her history, just before her illness, there is a questionable story of aspiration of a small chicken bone. Signs of dullness and diminished breath sounds at right lower lobe. No definite râles. It was at first considered possibly a case of bronchiectasis following pneumonia. Foreign body in bronchus was also considered.

Laboratory.—Sputum consistently negative for tubercle bacilli; Wassermann, negative; urine, negative; white blood-count, 11,700; polymorphonuclears, 75 per cent.; lymphocytes, 25 per cent.

Bronchoscopic Findings (January 13, 1931).—In the right main bronchus, twenty-nine centimetres from the upper incisors, was a mass nearly filling the lumen of the bronchus, soft and cauliflower-like.

FIG. 15.—(Case III.) Slight thickening of fissures.

FIG. 16.—(Case III.) Lateral view.

Course.—Patient continued to have hemoptyses. On January 17, 1931, fluoroscopy showed definite elevation of the right leaf of the diaphragm and X-ray showed an atelectasis of the right lower lobe. Patient was operated on March 28, 1931, and a mass arising from the main bronchus of the lower lobe close to its origin and extending into the main fissure at that point was noted. This extended upward and involved the mediastinal glands. The case was quite inoperable, so nothing further was done.

CASE III.—B. H. 16390, M. C., male, aged fifty-eight. Admitted July 3, 1930. Complained of productive cough. *Family History.*—Negative. *Past History.*—Important only in that he had pneumonia twenty years ago. Since then he has had a productive cough. Nine months previous he had a second attack of pneumonia which lasted four weeks and he has a cough and expectoration which have increased since then. For the last four or five weeks he has had dyspnœa on exertion and signs of fatigue. Sputum has been streaked for nine months. Lately he has lost four pounds in weight.

Physical Examination.—Negative except for the right lung. There was dullness from the seventh to tenth vertebral spines on the right and fine and medium râles were heard in this area. X-rays showed a thick interlobar septum and a dense lesion at the root. Reported as a patch of consolidation extending into the right middle lobe.

Bronchoscopy.—"Congestion of the trachea and carina. Considerable congestion and some crusting about the mouth of the right bronchus. On the lateral walls of the right main bronchus about thirty centimetres from the level of the upper teeth and very near the mouth of the middle lobe bronchus there is an area of soft tissue the size of a pea which bleeds freely on contact. Because of this further examination was impossible."

Diagnosis.—The clinical diagnosis lay between abscess or encapsulated empyema. The patient left the hospital but reëntered six months later, on February 27, 1931. Cough and expectoration had continued and increased. He had lost twenty pounds in weight. Temperature, 99°; pulse, 80 to 90; white blood-count, 15000.

Physical Examination.—As before. No clubbing of fingers or toes noted. Aspiration of chest in seventh space posterior: six centimetres from skin small amount of pus and

FIG. 17.—(Case III.) Oblique view. Thickening of fissures brought out clearly.

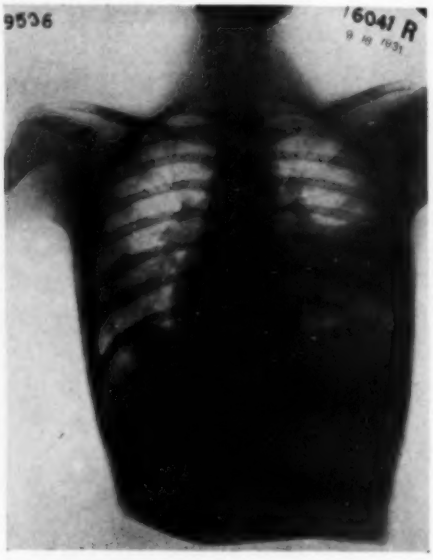

FIG. 18.—(Case IV.) Fluid in fissures.

blood obtained. Culture of this showed a hemolytic streptococcus. March 17, 1931, bronchoscopy repeated and biopsy taken. This was reported as epithelioma.

Operation.—Operated in two stages; the first April 15 and the second April 24. Lung very dense and adherent. Pus obtained on aspiration. Lung was opened at the second stage and cavity drained. Malignancy recognized grossly at this time. Patient died May 1, 1931.

Autopsy.—At autopsy the posterior part of the right lower lobe was found broken down and filled with a thick, cheesy, foul-smelling material. The right bronchus was necrotic and gangrenous. One and one-half inches from the bifurcation there was a hard ulcerated area. The middle and lower lobes showed bronchopneumonic consolidation. The fissures themselves were uninvolved. No mediastinal glands.

CASE IV.—The X-rays labelled Case IV are those of a young negress in the tuberculosis ward of Bellevue Hospital. During the course of a moderately extensive bilateral tuberculosis she developed fluid in the left chest with the X-ray films as shown. The lateral view is particularly striking as showing the whole interlobar fissure outlined with a collection of fluid somewhat anteriorly. Later this fluid extended and she developed a large effusion. The exact location was not proved by operation but

the shadows were so characteristic that we thought it worth while to include these films in our series.

The above cases illustrate some of the difficulties encountered in the diagnosis of pathology of the interlobar fissures. The physical signs are always obscure and confusing, and are sometimes absent entirely. A relatively small fibrinous or purulent interlobar exudate may give rise to an accompanying greater or smaller serous exudate in the pleural cavity. Three such cases were encountered by us during the past year. Here the physical signs were of no avail whatsoever. Also, the aspirating needle gave what seemed to be misleading results in that only clear blood-tinged serum was obtained, whereas further and deeper exploration revealed frank pus. Almost always in these cases, final reliance must be placed on the aspirating needle, the X-ray, or both. The pitfalls of each should be realized. Proper röntgenological examination means stereoscopic, oblique, and lateral films, and thorough fluoroscopic examination whenever possible. Stoloff describes a very good technic for this. According to him the great fissures are best visualized with the patient in the lordotic position and the tube at the level of the fourth or fifth thoracic vertebra.

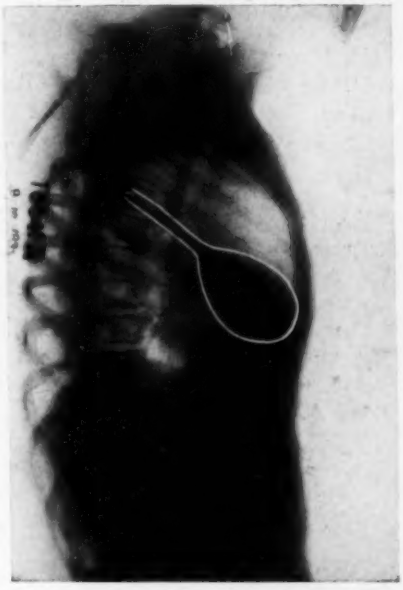

FIG. 19.—(Case IV.) Lateral view. Zone of fluid outlined.

Any proper interpretation of the findings by X-ray should presuppose an accurate knowledge of the anatomy of the fissures. Then if the aspirating needle is employed, it must be used intelligently and likewise with an understanding of the anatomy.

SUMMARY AND CONCLUSIONS

A brief résumé of the anatomy of the fissures of the lungs has been presented and a method described for outlining them by anatomical and röntgenological studies.

Also, several cases of interlobar disease have been presented in detail. Case I is a typical instance of interlobar empyema in the small transverse fissure. In Case II the tumor projected into the main fissure at the hilus although this was not diagnosed from study of the X-ray films. In Case III the interlobar fissure is shown and the diagnosis was made of interlobar empyema. Autopsy, however, revealed that the lesion was entirely intrapulmonary except for a slight thickening of the interlobar septum. Case IV seems to represent a very characteristic shadow of a sacculated collection in

the main fissure of the left lung. This illustrates excellently, even where the shadows are perfectly typical, the difficulties involved in the interpretation of X-ray films as to the relation of the lesions shown to the fissures.

Diagnosis of the interlobar disease is at best difficult. A thorough knowledge of the anatomy of the fissures must be combined with their visualization by X-ray and careful röntgenological interpretation.

The method of study outlined above is suggested as an aid to a better understanding of this problem.

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LINGUAL THYROID

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The presence of thyroid tissue at the base of the tongue in the region of the foramen cæcum is an uncommon condition. There have been approximately 130 such cases reported in the literature. Dore,[1] in 1922, in a Bordeaux thesis collected 102 case reports and gave a careful analysis of eighty-one of them. Bisi,[2] in 1930, has brought the literature in this subject up to date.

Apparently, the author to first cite a clinical case of lingual thyroid was Hickman,[3] in 1869, who reported the death of a sixteen-hour-old infant from asphyxiation caused by a goitre at the base of the tongue. Cattell and Hoover,[4] in 1929, report but two cases of lingual thyroid in over 7,600 thyroids operated on at The Lahey Clinic. As the symptoms, pathology and treatment of this condition are usually so much the same in the cases reported it seems unnecessary to collect and analyze the 130-odd case reports. The object of this paper, then, is to add another example of a lingual thyroid successfully operated upon and to discuss briefly the embryology of the thyroid gland and its effect on various possible positions of aberrant thyroid tissue.

Case.—The patient, M. L., a young American woman of twenty-five years, a bank-teller, was admitted to the First Surgical Division of Bellevue Hospital with a chief complaint of "lump in the throat" of five years' duration. Five years previously she had consulted her local physician who had told her that there was a tumor at the base of the tongue. Other than a feeling of a foreign body at the base of the tongue, there were no symptoms until three months before admission, when the "lump" began to cause trouble. She had occasional dysphonia and was bothered by a bad taste in her mouth in the morning and the presence of a brown sticky secretion together with a tickling sensation of the posterior pharynx. There was no history of hæmorrhage, dyspnœa, dysphagia, or pain. She said that she had lost fourteen pounds in weight in two months.

In the oropharynx arising from the centre of the base of the tongue in the region of the foramen cæcum and extending down and back there was a globular, sessile mass one and one-half inches by one inch. (Fig. 1.) The surface was smooth and covered with mucous membrane similar to that in the buccal region. Over its surface coursed two large veins superficially from the base of the tongue. This mass was firm. Its posterior and inferior aspect lay upon a short but otherwise normal epiglottis. The larynx was normal.

On palpating for the cervical thyroid it seemed that the isthmus was absent, but it was felt that the lateral lobes were present. There was no clinical evidence of myxœdema. The basal metabolism was minus 3 per cent. The rest of the physical examination was negative. The pulse rate was normal. The tumor was tapped and a small amount of straw-colored fluid was aspirated.

Operation.—August 29, 1930, under avertin anæsthesia, eighty milligrams per kilo-

metre, and five cubic centimetres 1 per cent. novocaine placed directly into the base of the tongue by the suprahyoid route, the tumor was attacked. Several strong silk sutures were passed through the tongue and the latter drawn forcibly forward. A transverse incision was then made in the mucous membrane at the junction of the tongue with the mass. The tumor was then shelled out by blunt and sharp dissection after finding a clear plane of cleavage. There seemed to be a rather definite submucous pedicle running to the region of the foramen cæcum.

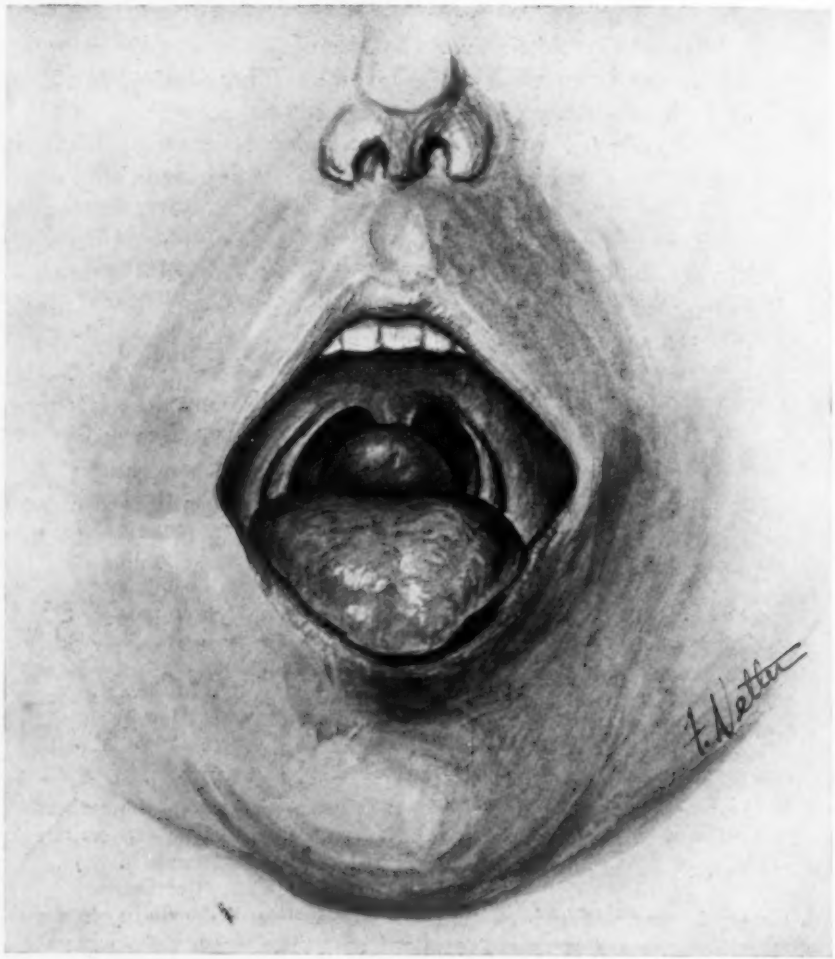

FIG. 1.—Showing the position of the lingual thyroid at the base of the tongue.

The pedicle was cut between ligatures. The mucous membrane was then brought together with three No. 1 chromic sutures.

As the patient was about to be transferred to the stretcher, she stopped breathing. By artificial respiration and inhalations of carbon dioxide and oxygen, normal respiration finally was established. We believe that this accident was due to a rather large dose of avertin.

The patient made an uneventful post-operative recovery and at the present time, four months post-operative, is completely well. There is no sign of local recurrence of tumor. The basal metabolism is minus 26 per cent. but there are no clinical signs of myxœdema.

Pathology.—The mass removed at operation weighs 8.5 grams, and measures 3.3

centimetres by 2.3 centimetres. On section there are several areas containing dark homogeneous colloid material. The rest of the tissue has the appearance of normal-looking thyroid. (Fig. 2.)

FIG. 2.—Lingual thyroid tumor after enucleation.

On microscopical examination there are areas of adenomatous tissue in between large numbers of dilated and irregular shaped follicles whose epithelium is high and which contain dark-staining colloid. (Fig. 3.) Some of the follicles contain a large

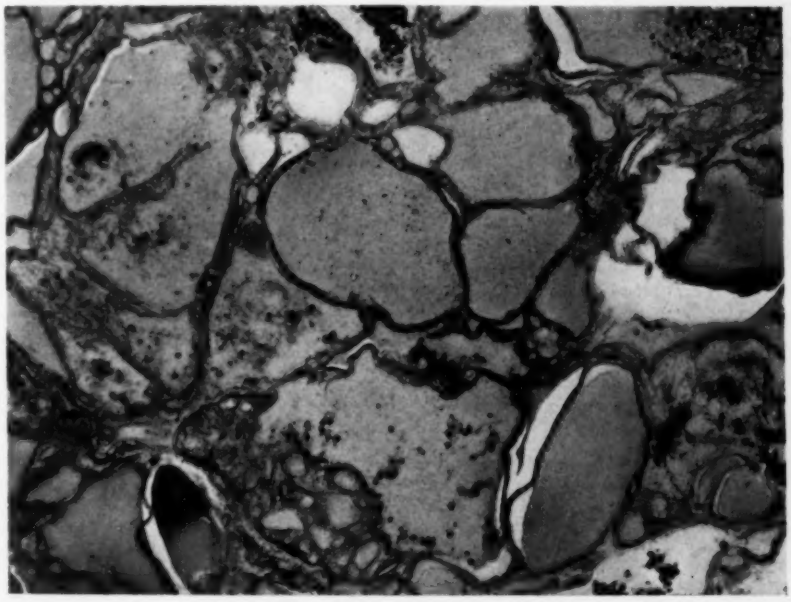

FIG. 3.—Section showing characteristic thyroid tissue with dilated follicles. (x75.)

number of cells which are distended with brown pigment. There is a marked fibrosis and a slight amount of round-cell infiltration.

Pathological diagnosis.—Mixed colloid and adenomatous thyroid.

Embryology.—The whole of the functioning adult thyroid comes from a median anlage in the floor of the pharynx. This anlage occurs early. In 2.5 millimetres embryo, it develops a projection which soon takes the form of a sac or pouch. As the latter grows it moves backward and downward, retaining its connection with the floor of the pharynx by a narrow stalk, the thyroglossal duct. The latter has an orifice which opens into the pharynx as the foramen cæcum. As the pouch and its duct migrate downward into the neck it becomes bilobed and the thyroglossal duct has a double lumen. The stalk or thyroglossal duct then atrophies, and the bilobed pouch becomes differentiated into the isthmus and the lateral lobes of the thyroid gland. The hyoid bone develops later and the thyroglossal duct may pass in front of, through, or behind the bone.

It was thought at one time that the ultimobranchial bodies were the lateral thyroid anlages. They arise from the ventral part of the fifth pharyngeal pouch and are described in some mammals as actually contributing active thyroid tissue to the lateral lobes. They have been described as fusing with the lateral lobes in the human, but whether they contribute actively functionating thyroid tissue is in doubt. If they do it would be hard to explain those cases in which the median thyroid anlage had been arrested in its descent, forming, say, a sublingual mass of thyroid tissue, and when the latter was removed surgically, myxœdema occurred. This condition, an extremely important one to know about, is not at all uncommon. If active thyroid tissue was formed by these lateral anlages, the ultimobranchial bodies, true ectopia thyroidis would be hard to account for as they should theoretically supply enough thyroid to prevent the individual from developing myxœdema.

The few embryological facts outlined above explain satisfactorily the common variations of position of the thyroid found in man. Thyroid tissue may then be found at any point along the course in the descent of its median anlage from its original position at the foramen cæcum to its ultimate site on the upper tracheal rings. Thus we may find it at the foramen cæcum as a lingual thyroid in the substance of the tongue, as an intralingual thyroid below the hyoid bone, as was described by Verneuil[5] in 1853 (he being the first to recognize and report the presence of accessory thyroid tissue) as thyroid lying in the lower part of the thyroglossal duct (pyramidal lobe), and finally normal gland.

It is possible, of course, to find accessory thyroid tissue in other positions than in close relation to the normal situation of the gland or the course of its descent. It would be due to a small piece of the original remnant that had wandered off to any remote situation.

Leech, Smith and Clute,[6] and Cattell and Hoover[4] have described aberrant thyroid tissue in lateral positions with no demonstrable connection with the main body of the gland. All these cases, however, showed a low-grade malignancy. They believe that these were derived from the ultimobranchial bodies.

The thyroid gland may be absent, the isthmus may be lacking or only one lobe may be present.

We believe that the most important clinical fact to be determined from the embryological development of the gland is whether in these cases of lingual thyroid the whole functionating gland is represented in the lingual element, true ectopia thyroidis, or that the normal gland also is present in its usual pre-tracheal position. The reason for this is obvious.

Dore,[1] in analyzing eighty-one cases of lingual thyroid, reports myxœdema developing in seven following surgical removal of the lingual tumor, a ratio of about one in every eleven cases. More recently, Hartley[7] reports a case of true ectopia thyroidis in which he removed a tumor the size of a cherry from above the hyoid bone, the patient developing marked symptoms and signs of hypothyroidism in eight weeks. Lahey,[8] Cattell and Hoover,[4] Torrigiani,[9] and Bisi[2] have also reported such cases. Torrigiani merely took a biopsy from the lingual tumor because he could not feel the normal thyroid. This we believe to be an extremely important point. Hartley emphasizes the fact that if the isthmus of the gland cannot be felt one should be suspicious that the condition is one of an ectopic gland.

The lingual thyroid is much more common in women than in men. The ratio is about eight to one. The average age of the patients is twenty-three years. The onset of the symptoms very frequently occurs at the age of puberty, although some adults have given a history of such tumor being present since birth. Several cases of lingual thyroid in the new-born have been reported.

The symptoms are those of any benign tumor at the base of the tongue, the feeling of a foreign body at the base of the tongue, dysphonia, dysphagia, dyspnœa and actual asphyxia, as in Hickman's case. Hæmorrhage from the large vessels which may course across the tumor is not uncommon and occurred in eight of Dore's eighty-one cases. On inspection the mass is liable to be missed, unless the tongue is pulled far forward. The ordinary method of depression tends to push the mass out of view. The tumor is frequently first seen by the laryngologist; this occurred in our case. The tumor, which may be deeply imbedded in the root of the tongue, usually projects from the dorsum. It is single, situated in the region of the foramen cæcum, and usually has a broad base. Harvey[10] has recently described one with a pedicle, a rare condition. The tumor is red in color, slightly lobulated and covered with normal mucous membrane which may contain several large veins arranged in typical manner. The various sizes of the cases observed have ranged from that of a pea to that of an orange. In the latter case the entire oropharynx was filled by the mass.

An extremely careful examination of the neck should be made to ascertain the presence or absence of the normal thyroid gland. If the normal gland cannot be felt, one should hesitate to remove the lingual thyroid unless the symptoms arising from it make its extirpation imperative. Myxœdema can, of course, be fairly well controlled with thyroid feeding but occasionally

this distressing condition fails to be relieved by medication. Pre-operative and post-operative basal metabolism rates should of course be done. The surgical approach to a tumor of this kind depends on its exact situation. In the authors' case the oral route was obviously the simplest. For those tumors lying deep in the tongue or just above the hyoid bone a suprahyoid incision would be most satisfactory.

In conclusion, we wish to draw attention again to the change in the basal metabolic rate of this patient from minus 3 per cent. pre-operatively to minus 26 per cent. post-operatively. While other clinical manifestations of myxœdema are at present lacking in this patient, she will be started on a course of thyroid feeding. The amount of the feeding and its duration will be controlled by her follow-up examinations and future metabolism tests.

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SALIVARY CALCULI *

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During the past eleven years ninety-six patients have consulted us with symptoms indicating obstruction of ducts of salivary glands. In seventy-three calculi were demonstrated clinically or radiographically. There is a very extensive literature on this subject, many observers reporting isolated cases, while a few writers present analyses of large series. It is obviously impossible to review all of the literature here. Recent personal series are reported by Harrison,[1] in 1926 (twenty-seven cases), and by New and Harper,[3] in 1931 (seventy cases). Up to the time of Harrison's paper, he states that search of all available literature from 1825 resulted in finding only 375 cases. We feel that our experience is sufficient justification for presentation of a paper on a condition which, while much more common than the figures quoted would indicate, yet is frequently overlooked.

Etiology.—It is not our purpose to dwell upon the theories that have been advanced to account for the formation of salivary calculi. Some writers claim that inflammation in the gland itself is a common cause of stone formation. Against this is the frequency of inflammation of the parotid gland and the infrequency of stone formation in this region. The most significant work on the etiology and pathology of salivary calculus has been done by Söderlund[8] and Naeslund, of Sweden. In 1919, Söderlund first definitely associated salivary calculus formation with actinomycotic infection. He[9] has since reported a series of forty-one cases in which examination of the calculi showed the presence of actinomycetes in all. He and Naeslund believe the cause in some cases to be the saprophytic actinomycetes inhabiting the mouth, while in others that the organisms are introduced into the salivary ducts directly from outside the body. These writers hold that colonies of the organisms in the ducts cause a decomposition in the protein of the saliva, bringing about a precipitation of calcium salts by reason of a change in the hydrogen-ion concentration. The lime salts are deposited around the colonies of the organisms. Naeslund states that other bacteria can also cause precipitation of lime salts from saliva in the same way, but that the physical make-up of these other bacterial colonies is not so favorable for the deposit in and around them of the lime salts as it is in the case of the mycelium-forming actinomycetes. Naeslund[2] examined fifty cases of salivary calculus and found an actinomycotic stroma in all. He was also able experimentally to produce calculi from cultures of actinomycetes obtained from natural salivary calculi. He found in salivary calculi saprophytic forms of actinomycetes as well as the Wolff-Israel

* Read before the Philadelphia Academy of Surgery, March 7, 1932.

pathogenical strain. This would explain why salivary calculus formation can be so frequently present unaccompanied by a pathological actinomycotic process in the tissues. This conception of the cause of salivary calculus has so recently been brought to our attention that we have not had an opportunity to investigate it in our own cases, but we shall do so as new cases present themselves. In most salivary stones a combination of calcium phosphate and calcium carbonate predominates.[4, 6, 10] Many writers stress the presence of foreign bodies in the salivary ducts as the starting point of calculus formation. The actual demonstration of a macroscopical foreign body in the calculus is rare. In one of our cases of abscess of the parotid gland, we found a husk of wheat impacted in the duct, but no calculus had formed around it. There was an actinomycotic infection in this case.

FIG. 1.—Swelling of left submaxillary salivary gland, due to obstruction of duct by large calculus shown in Fig. 5. Note absence of trismus.

Of the seventy-three cases of our series in which calculi were present, sixty-six were connected with the submaxillary gland or duct, and seven with the parotid, a proportion of almost 10 to 1.

Of the submaxillary cases forty-seven occurred in males and nineteen in females, a proportion of about 2½ to 1. As to the side involved, there were thirty-seven on the left side, twenty-three on the right side, two were bilateral, and in four the side was not recorded. The X-ray revealed the stones in forty-four cases of sixty-six, while they were demonstrated clinically in twenty-two.

Of forty-three cases in which the age was noted, the youngest was sixteen and the oldest seventy-nine years. A larger number occurred in the third decade than in any other.

Of the seven parotid cases, five occurred in males and two in females. The

right side was involved in three, the left in three and in one the side was not recorded. The X-ray showed the stones in four cases while in three cases they were demonstrated clinically. Single stones were present in all of the parotid cases.

Symptoms and Diagnosis.—*Submaxillary Gland and Duct.*—In typical inflammatory obstruction of the duct of Wharton by a calculus, no difficulty should be encountered in diagnosis. There will be an acute or a subacute swelling in the submaxillary region, well circumscribed, and tender to pressure, and not adherent to the overlying skin (Fig. 1). Fifty-nine of sixty-six

Fig. 2.—Illustrates how a calculus in anterior portion of submaxillary duct may be masked by shadow of mandible in extra-oral X-ray film. (Radiograph by Dr. L. M. Ennis.)

patients presented a submaxillary swelling. Pain may be severe, especially on attempts at swallowing. This painful enlargement is particularly noticeable at meal-times (salivary colic), an association noted in thirty-six of our patients. There is no limitation in opening the mouth. The duration of symptoms in our cases varied from a few days up to seventeen years. Nineteen were seen during the first attack and in thirty-seven multiple attacks were recorded, with intervals of comparative comfort between. During an acute attack, a tender, œdematous swelling will generally be found in the floor of the mouth along the course of the duct, on the same side as the submaxillary enlargement. The outlet of the duct at the side of the frenum of the tongue

may be reddened, and pus may be expressed from it. This symptom was recorded in forty-four of sixty-six cases. A tender hard nodule—the calculus—may be felt somewhere along the course of the duct in the floor of the mouth, by combined intra-oral and extra-oral palpation. Fever and leucocytosis are usually present during the acute attacks.

The diagnosis is easy when the stone is seen to be partly extruded from the orifice of the duct. It is in the milder or subacute recurrent cases that there is more excuse for overlooking the true condition. Here, the only indication may be more or less mild recurrent attacks of circumscribed tender swelling in the submaxillary region, with no particular complaint in the floor of the mouth. The likelihood of a stone should, however, always be thought of under these circumstances, and careful inspection will frequently show reddening or swelling about the orifice of the suspected duct, or pressure may

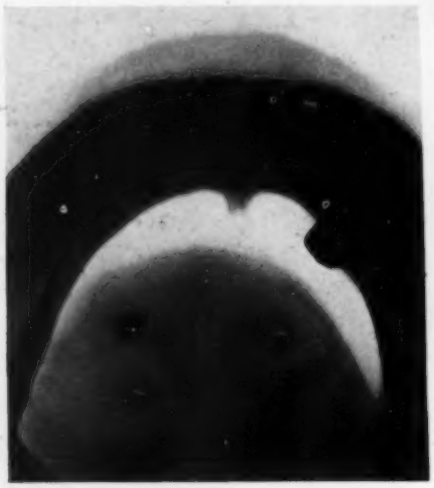

FIG. 3.

FIG. 4.

FIG. 3.—Same case as Fig. 2. Calculus clearly shown in intra-oral occlusal film. (Dr. L. M. Ennis.)
FIG. 4.—Intra-oral occlusal film fails to show calculus in posterior part of submaxillary duct. (Dr. L. M. Ennis.)

force out a little pus. On minute palpation a point of tenderness or a hard nodule may be felt in the floor of the mouth. X-ray examination is valuable in confirming the diagnosis. Many submaxillary stones are overlooked by failure to make a proper X-ray examination. The usual small dental films placed against the lingual sides of the teeth and gums will, of course, not cover the submaxillary duct region. The ordinary external film of the lower jaw region will frequently fail to show a small stone situated in the anterior part of the duct as the stone shadow may be hidden by that of the mandible. (Fig. 2.) Where a calculus is suspected in the anterior two-thirds of Wharton's duct, a No. 2 film (2½ by 3¼ inches) is placed in the occlusal plane between the upper and lower teeth as far back in the mouth as possible with the sensitive side down, and the patient instructed to bite on it. The rays are directed from beneath the chin. This will give a clear shadow of any opaque substance

in the floor of the mouth. (Fig. 3.) If the stone is farther back, near the beginning of the duct, a lateral extra-oral film may be necessary to show it. (Figs. 4 and 5.) Multiple calculi may be shown by the X-ray, when unsuspected clinically, a fact which has an important bearing on treatment, so that even though a positive diagnosis has been made clinically, X-ray examination should not be neglected, for this reason. (Figs. 6 and 7.)

Differential Diagnosis.—Obstructive enlargement of the submaxillary salivary gland is commonly mistaken for a lymphadenitis or a cellulitis due to infection from teeth or tonsils. In the majority of cases that have come to

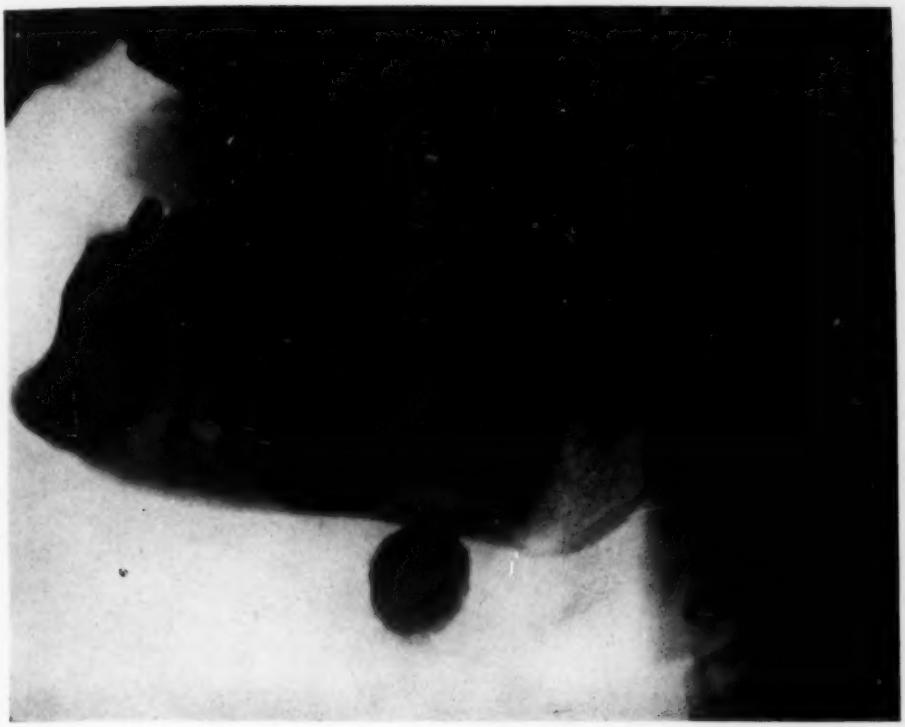

FIG. 5.—Same case as Fig. 4. Extra-oral film showing large calculus in posterior part of duct. This calculus was almost spherical, about two centimetres in diameter, weighed three grams, and was removed by an incision in the mouth. (Dr. L. M. Ennis.)

our notice, the patients have been told that the trouble was probably due to infection from the teeth and many have had one or more teeth extracted without relief. Careful note of history of symptoms, and examination as outlined above, with *absence of trismus*, will usually exclude a cellulitis of dental origin.

The presence of a subacute swelling in the submaxillary region, associated with soreness in the floor of the mouth, especially in a person of middle age or beyond, may lead one to entertain a suspicion of malignancy. In a carcinomatous metastasis to submaxillary and cervical lymph-nodes, the mass in the neck is usually fixed and markedly indurated, frequently bound both to

the skin and to the bone. The submaxillary gland when enlarged from stone in the duct is usually more deeply seated, is not fixed to skin or bone, and has an elastic feeling. The X-ray examination usually clears up the question.

Ranula is confused with obstruction of the submaxillary duct by writers from time to time, and considerable confusion seems to exist regarding this condition. Statements are constantly appearing in the medical and dental literature[5, 7] that ranula, a cystic swelling of the floor of the mouth, may be due to a calculus lodged in the duct of the submaxillary gland. Submaxillary duct obstruction cases should never be classified with ranula, the symptoms being entirely different. Ranula is a soft, painless, transparent swelling beneath the mucous membrane of the floor of the mouth, containing clear ropy fluid. The exact cause is unknown, but it may be due to inflammatory closure

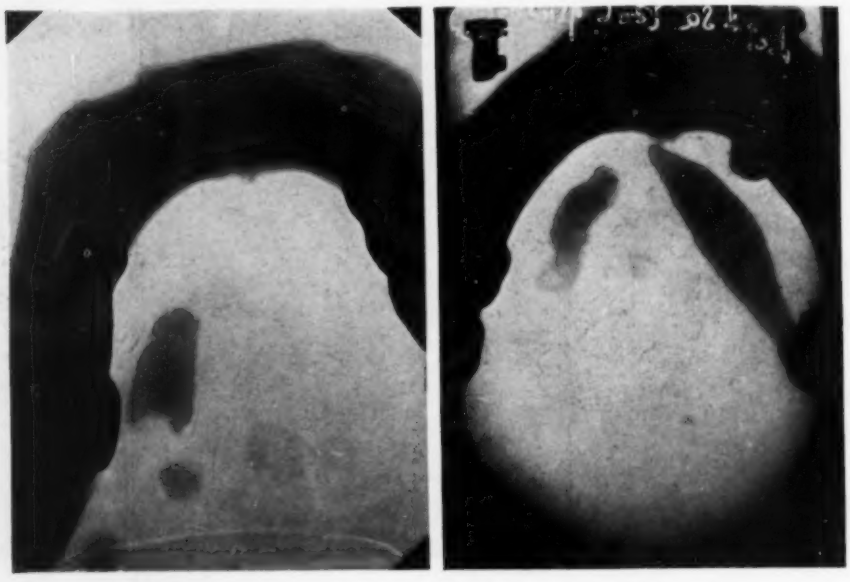

FIG. 6. FIG. 7.

FIG. 6.—Three calculi in one submaxillary duct. (Dr. L. M. Ennis.)
FIG. 7.—Bilateral submaxillary duct calculi. One was two centimetres and the other three centimetres in length. (Dr. G. E. Pfahler.)

of one of the ducts of the sublingual gland or of one of the smaller mucous glands in this region. It is never associated with a calculus, nor with a swelling in the submaxillary region, as would be the case if the submaxillary duct were involved. Furthermore, in ranula the submaxillary duct can usually be identified and isolated completely from the cystic swelling.

Parotid Gland and Duct.—Here, the symptoms differ only in location from those of submaxillary duct obstruction. All of our seven cases were manifested by a painful external swelling over the region of the parotid gland. Three gave a history of increased pain and swelling in relation to eating. In six pus could be expressed from the orifice of Stenson's duct. Three patients were seen during the first attack while four had had several attacks,

in two cases, over a period of two years. Parotid calculi are much more difficult to demonstrate radiographically than those in the submaxillary region. The examination is best made by the anteroposterior position, the operator endeavoring to throw the parotid gland region on the X-ray film external to the shadow of the ascending ramus of the lower jaw. Sometimes a calculus can be demonstrated by placing a small dental film in the vestibule of the mouth over the duct with the sensitive side toward the mucous membrane of the cheek. (Fig. 8.) Of seven parotid cases, the X-ray examination was positive in four. In one case the calculus was encysted in the gland substance.

TREATMENT.—*Submaxillary Calculus.*—The treatment of obstructive enlargement of the submaxillary gland from calculus in Wharton's duct is primarily removal of the calculus. If the stone is in the anterior two-thirds of the duct, this can be accomplished by an incision through the mucous membrane of the floor of the mouth under local anæsthesia. The cases vary greatly in difficulty. As a general thing the larger the calculus the easier its removal. The most difficult cases are those of small calculi which are movable in the duct. Anæsthesia is best obtained by injecting the lingual nerve, as in the mandibular injection for the extraction of teeth. The mucous membrane is incised in the direction of the duct. A large calculus can then be readily felt with the finger, the duct incised, and the stone liberated. In case of a small stone, with little or no surrounding inflammatory reaction, the tissue can be grasped with forceps behind the stone, or a suture can be passed around the duct to prevent the stone from slipping back while the incision is being made. In non-suppurative cases, the mucous membrane incision can be sutured without drainage. If much inflammatory reaction or suppuration be present, a small wick of gauze or strip of rubber dam should be left in the incision. There is frequently considerable reaction following the trauma of this operation, lasting for a few days, which may be partially controlled by hot mouth washes and the application of ice externally. Pain may call for a sedative, although in most cases relief of pain and discomfort is almost immediate after the operation.

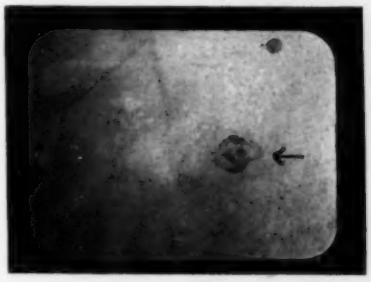

FIG. 8.—Calculus in parotid duct shown by small dental film placed against mucous membrane of cheek. (Dr. L. M. Ennis.)

If the calculus lies near the point at which Wharton's duct is given off from the gland, its removal by external incision is indicated. In cases of long standing, the gland undergoes degenerative changes from chronic inflammation, and even removal of the obstruction does not effect a return to normal. Here, it is advisable to remove the gland as well as the stone. In this operation, the usual skin incision runs about an inch below and parallel with the lower border of the mandible from just behind the symphysis to the angle. The platysma is divided along the same line and turned up as a separate layer. In dissecting out the gland the facial artery and vein are

divided and tied. In completing the operation the platysma and skin are sutured in separate layers. A small rubber dam drain is usually inserted for twenty-four or forty-eight hours. Very frequently one of the cervical branches of the facial nerve is cut during the operation, causing a characteristic inability to depress the corner of the mouth, due to paralysis of the triangularis menti muscle. Spontaneous recovery or improvement may occur with time. This accident is difficult to avoid, but there is less chance of its occurrence if the incision be made well below the border of the jaw.

In our series of fifty-seven cases which came to operation, fifty-one were removed by incision within the mouth, and six by external incision.

Parotid Calculi.—These are usually removed by an incision into the duct from the mouth. Of six cases in our series, the duct was opened from the mouth in five, while in one case of stone encysted in the gland, this was removed through a skin incision. Since there was no obstruction of the duct in this case, no permanent salivary fistula resulted from the operation.

SUMMARY AND COMPARISON WITH OTHER SERIES

	Submaxillary	*Parotid*	*Sublingual*	*Total*
Ivy and Curtis	66	7	—	73
Harrison	15	10	2	27
New and Harper	66	3	2	71

Incidence According to Sex

	Males	Females	Total
Ivy and Curtis	52	21	73
Harrison	19	8	27
New and Harper	45	25	70

Side Affected

	Right	Left	Bilateral	Not Noted
Ivy and Curtis	26	40	2	5
Harrison	16	11		
New and Harper	Right almost twice as often as left. Bilateral 2.			

Operation

	Removal through Mouth		*Removal by External Incision*	
	Submaxillary	Parotid	Submaxillary	Parotid
Ivy and Curtis	51	5	6	1
New and Harper	43	Not Stated	27	Not Stated

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ACUTE EMPYÆMA OF THORAX*

The Immediate and Late Results in a Hundred Consecutive Cases

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This paper is based on an analysis of the immediate and late results of 100 consecutive cases of acute empyæma surgically treated at the Reading Hospital from 1920 to 1930.

The data covering the end-results was obtained by a questionnaire sent to the patient and information received from the patient, a member of the immediate family, or from the family physician. The questionnaire was sent out three months after the last patient was discharged from the hospital.

Ætiology.—In the series of cases under consideration, 75 per cent. occurred as a complication of pneumonia. In 10 per cent. pleurisy was considered the cause. In 11 per cent. the origin of the trouble was not clear. The patients in most instances in the latter class complained of malaise, vomiting, fever, and some difficulty in respiration. Grippe or influenza was the preceding illness in four patients. Again, in one case, a cold, and in another, a discharging ear was considered to be the ætiological factor. Table I presents the ætological organism and the mortality in each group.

Table I

Culture	Number of Cases	Deaths	Mortality Per Cent.
Not stated	32	1	3.12
Pneumococcus	26	0	0.
Streptococcus	25	5	20.0
Mixed	11	3	27.27
Staphylococcus	6	1	16.66

The age distribution is best demonstrated by Table II which shows the age and the mortality.

Table II

Age	Number of Cases	Deaths	Mortality Per Cent.
1 to 2 years	21	3	14.28
3 to 12 years	46	2	4.34
Over 12 years	33	5	15.15

The youngest patient was eight months and the oldest was seventy-three years. Both of these recovered.

Sex Distribution.—There were fifty-six males and forty-four females.

Side Involved.—In fifty-five instances the right pleural cavity was involved and in forty-five the left side was affected. In one case the condition was bilateral. It is probably not of much significance that in the female the left side was as frequently involved as the right, whereas in the male the

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right side was the seat of trouble in thirty-four instances and the left in twenty-one instances.

Treatment.—The war treatment of empyæma, although it was handling the influenza type of empyæma, an entirely different empyæma from our common everyday variety of empyæma, has nevertheless brought out two important lessons. *First*, the extreme value of not opening the chest too hastily, and *second*, the employment of the most conservative operation in the very sick patient.

In an old empyæma where drainage is paramount, any procedure short of rib-resection is futile.

In all cases of the present series aspiration was done first. This was done in most cases only as a diagnostic procedure. The type of surgical treatment employed can best be seen by the chart in Table III. It will be noted that sixty-nine patients had partial resection of one rib with the insertion of several rubber tubes. Twenty-two patients had intercostal drainage instituted by intercostal incision or by trochar. The drain in these cases consisted usually of a rubber tube, or more infrequently, a metal cannula with the drain left open. In only a few cases was the drain used as a closed method of treatment. Six patients had intercostal drainage followed later by a partial rib-resection. One patient had a partial rib-resection with counter-drainage by a lower incision. In two patients aspiration was the only treatment employed.

The patient with bilateral empyæma had a thoracotomy on the right side, which was also the side first and most extensively involved, and later, after the lung on this side had expanded satisfactorily, a thoracotomy was done by rib-resection on the opposite side. The patient had a gratifying convalescence and a complete recovery.

TABLE III

	Type of Operation				
	Rib Resection	Trochar and cannula or 1 tube	Aspiration	Intercostal drainage and later resection	Resection and counter drainage
Recovered	63	20	1	6	0
Died	6	1 open and 1 closed	1	0	1

Anæsthesia.—Table IV shows the type of anæsthesia employed.

TABLE IV

Anæsthesia	Cases
(Local Novocain)	58
Nitrous Oxide	22
Ether	10
Ether, nitrous oxide and oxygen	3
Local and nitrous oxide	2
Local and ether	2
Not stated	3

Local infiltration with novocain solution was generally considered to be the choice method of anæsthesia. The patients who received ether were all among the first in the series. In some instances general anæsthesia was resorted to because the patients were too apprehensive.

Of the ten patients who died seven had local anæsthesia. One had nitrous oxide and two had ether. The one who had nitrous oxide died eight hours after the operation. Of the two who had ether, one died three days and the other one month after the operation. In none of these cases did the anæsthetic seem to be a factor in the cause of death.

Post-operative Treatment.—The post-operative treatment has been fairly simple. Frequency of dressings was determined by the amount of drainage and temperature, a rise in the latter suggesting at times the plugging of a drainage tube and the consequent retention of pus. Irrigation of the pleural cavity was not employed regularly. In seventy patients there were no irrigations or instillations of fluid into the cavities. In thirty patients these treatments were carried out and consisted chiefly of Dakin's solution usually ½ per cent. (seventeen cases); normal saline (seven cases); iodine fluid drams 1 to fluid ounces 1 (two cases); gentian violet (two cases) and mercurochrome ½ per cent. (two cases). There is not much to substantiate that these treatments were of any particular benefit as long as the drainage tubes were open.

Most of these patients showed general improvement of strength and weight. Tonics were given and an accurate record was kept in most cases of the weight. Generous diets were permitted and the patients were often wrapped up well and the bed moved into the sun and air when the weather permitted.

The tubes were removed early, washed, and easily reinserted, gradually reducing the number of tubes (usually there were two), as well as the size and length.

The inflation of toy balloons and the blowing of fluid from one bottle into another was encouraged early, particularly if there was general improvement. To further augment lung expansion the patients were permitted to sit on the side of the bed or on a chair as early as the seventh or tenth day.

Routine blood counts and X-rays of the chest were taken.

Transfusions were resorted to in an increasing frequency. The direct type of transfusion was the one usually given. Several of the patients received three transfusions. These were not given for hæmorrhage but to counteract the definite anæmia so often seen in this disease, and particularly if it has been of long standing.

It is of significance that the private patient was discharged earlier than the ward patient, no doubt due to the fact that the general admitting condition was better, and further, the care at home after the operation could be counted upon to be better than that of the charity patient.

The average stay in the hospital, exclusive of the patients who died, was one month and eighteen days.

TABLE V

Complications

Type	Cases	Type	Cases
1. Meningitis	1	11. Acute otitis media	4
2. Gastroenteritis	1	12. Vaginitis, gonococcic	1
3. Peritonitis	1	13. Herpes facialis	1
4. Syncope attacks	1	14. Hiccoughs	2
5. Conjunctivitis	1	15. Chronic otitis media	2
6. Bronchial fistula (temporary)	5	16. Decubitus	1
7. Infected finger	1	17. Paronychia	2
8. Marked anæmia	12	18. Whooping cough	4
9. Scarlet fever	3	19. Epistaxis	1
10. Furunculosis	6	20. Chronic nephritis	1
		21. Osteomyelitis of right hip	1

Immediate Results.—Of the 100 cases there were ten deaths. Forty-four were discharged with the wound completely healed. Twenty-four were discharged with slight drainage from a granulating sinus. All of them were well advanced in healing. Twenty-two were discharged with drainage material, chiefly a rubber tube, still in the pleural opening.

Late Results.—At this writing, of the ninety who left the hospital alive, eighty-two answered that they were well and active. Two were draining with recurrences. Two are dead, one having died of diabetes and another of apoplexy, but both had completely recovered from the empyæma a number of years prior to their demise. Four could not be traced.

Of the twenty-two patients who had been discharged with drains still in use, the average healing was two months and three weeks with the exception of one. In this case the healing was delayed for three years, during which time she was in Colorado for tuberculosis. She has now been entirely well for over two years.

Recurrences.—In the present series there are six cases where chronic or recurrent empyæma followed. Two were adults, one forty-four and the other fifty-nine years of age. The one had six recurrences and was drained an equal number of times and has had a drainage tube for the last three months. The primary operation was an intercostal drainage with a rubber tube without rib-resection. The other had two recurrences since his primary operation, which consisted of a rib-resection. Both times he recovered promptly.

The other four recurrences were in children. All of these had only one recurrent attack and since then all of them have been apparently healthy and well. One of these had only an intercostal rubber tube drainage for the first operation, but at the recurrence had a rib-resection with exploration of the cavity. Another one had an intercostal drainage followed in three weeks by a partial rib-resection. Two of them had a partial rib-resection as their primary operation.

Deaths.—No. 1.—Girl, fourteen years, temperature on admission 102°, pulse 120, respiration 35. Pain in right side of chest for fourteen weeks. Associated with this were

headaches, coughing and chills. Her temperature was septic and gradually she failed in strength and lost considerable weight. Marked dullness on the right side of the chest anteriorly and posteriorly. Aspiration gave thick pus containing pneumococci and staphylococci. The day after admission 3 centimetres of the eighth rib in the posterior axillary line was removed and two rubber tube drains inserted. The immediate reaction was satisfactory but there was gradual failure in strength. Some sepsis continued, occasionally there was vomiting and toward the end there were frequent involuntary stools. Death occurred one month after the operation. No post-mortem examination.

No. 2.—Female, fifteen years. She was sick at home one week. On admission to the hospital her temperature was 103°, pulse 124, respiration 38. There was dullness over the left chest anteriorly and posteriorly. Diagnostic aspiration done. Ten days after admission aspiration was positive for pus which contained many streptococci. A rib-resection was done the following day. A large amount of pus was released. Three tubes were inserted. Poor reaction followed the operation. Death three days later. No post-mortem examination.

No. 3.—Male, twenty-eight years. Pleurisy was his first complaint. He was admitted to the hospital two weeks after the onset of the trouble. Temperature was 98°, pulse 130, respiration 28. Diagnostic aspiration revealed pus. No particular organism was isolated. The same day 2 centimetres of the eighth rib in the posterior axillary line was removed. Much pus was evacuated and two rubber drainage tubes were inserted. The patient did not rally and died eight hours later. No post-mortem examination.

No. 4.—Male, nineteen years. Started with severe pain on the left side of the chest, front and back. Gradually this became better. As time went on his temperature came down, but at the end of one month he began to get short of breath, persisted in having some temperature and occasionally expectorated purulent fluid. On admission his temperature was 103°, pulse 100, respiration, 35. Admission one month after inception of thoracic pains with dyspnea. Marked limitation of motion on the left side of the chest, over which area there was also dullness to percussion. The right side of the chest was hyper-resonant. Aspiration in the eighth interspace in the posterior axillary line gave 750 cubic centimetres pus. Staphylococci were isolated. X-ray showed marked pleural effusion on the left side. Three days after the aspiration an intercostal tube was inserted and 2000 cubic centimetres of pus again obtained. The convalescence was fairly satisfactory during the first month, but with the beginning of the second month he gradually lost ground. The drainage tube was left in place and was open. Toward the end his temperature became subnormal with the pulse ranging between 110 and 120 and the respiration between 20 and 25. Death occurred one month and twenty days after operation.

No. 5.—Male, forty-nine years. Had been in the hospital three weeks for the repair of an inguinal hernia. Toward the close of his convalescence, which was otherwise uneventful, he developed a slight cold, but insisted on going home. Shortly after returning home the cold became progressively worse and with it there was sharp pain on the right side of his chest, at first only with breathing. This became better but he continued to have a temperature. There was some shortness of breath and loss of weight. One month after his release from the hospital he was admitted again. Temperature 101°, pulse 120, respiration, 30; limited expansion on the right side of the chest; tactile and vocal fremitus increased on the right both anteriorly and posteriorly; percussion dull over the lower half of the right chest and numerous crackling râles heard over this same area; aspiration gave pus with many streptococci. The day after admission a rib-resection was performed under local anæsthesia. Four centimetres of the eighth rib in the anterior axillary line were removed and two drainage tubes inserted. At first the convalescence was satisfactory, but soon he became weak, toxic and quite rapidly became worse and then unconscious. A spinal puncture revealed cloudy spinal fluid containing many streptococci. Patient died fifteen days after operation.

A complete post-mortem examination was made. An acute suppurative cerebro-spinal meningitis was found. The cultures from the meninges, the pericardium, and the right pleural cavity all contained streptococci in large numbers.

No. 6.—Male, fifteen months. The onset consisted of a cold, which became progressively worse, with vomiting and progressive difficulty in breathing. He was admitted to the hospital ten days after the onset. Temperature 104°, pulse 150, respiration 50. There was much lagging on the left side of the chest, marked dullness to percussion and distant breath sounds.

X-ray of the chest showed marked pleural effusion on the left side. Hæmoglobin 38 per cent, red blood-cells 3 million, white blood-cells 11,600, polymorphonuclears 80.

Aspiration gave thick greenish pus containing many pneumococci. The following day a rib-resection was done and two tubes inserted. A moderate amount of pus was released. The child did not rally very well and died eighteen hours later.

A post-mortem examination was made. The left lung was markedly collapsed and there was some compensatory emphysema on the right side. Very little pus was found in the left pleural cavity.

No. 7.—Male, nine months. The illness started with a cough, dyspnœa and fever. At the end of three weeks the patient was admitted to the hospital. Temperature 104°, pulse 144, respiration 43. Expansion on the right side of the chest poor; labored breathing. On the right there was marked dullness to percussion. There was no impairment of percussion on the left side.

Under 5 cubic centimetres of ½ per cent. novocain solution a needle was inserted in an intercostal space, 5 cubic centimetres of pus was withdrawn. The child died very shortly thereafter.

Post-mortem examination showed a greatly enlarged pleural cavity on the right side. The cavity was filled with sero-purulent fluid approximately 700 cubic centimetres. The parietal layer of the pleura was covered with a yellowish purulent exudate. The right lung was markedly collapsed, particularly the lower lobe. The left lung showed moderate œdema and some congestion at the base.

No. 8.—Female, two years. Two months before admission she developed a fever and became restless and irritable. On admission temperature was 102°, pulse 160, respiration 55. Motion on the right side of the chest was greatly limited and percussion was dull both front and back. X-ray showed right-sided pleurisy with effusion. Aspiration gave purulent fluid containing many streptococci. Under local anæsthesia, by a small trochar and cannula, a small intercostal tube was inserted and 75 cubic centimetres of pus was withdrawn. The patient went from bad to worse and died within five hours.

A post-mortem examination was made. A small amount of pus was found in the right pleural cavity. Both lungs showed bilateral bronchial pneumonia, especially marked on the right, with some small areas of consolidation found especially at both lung bases. Abdominal examination negative.

No. 9.—Male, six years. Three weeks before admission to the hospital he developed a cold in the head with a slight cough and occasional pain in the left ear. Two weeks after the onset he developed chills and was more feverish. The child remained toxic and began to lose weight and strength. Admitted with a temperature of 102°, pulse 125, respiration 38.

X-ray examination showed effusion on the left side of the chest. Percussion note was dull over the entire left chest. Moist râles were also heard. Aspiration gave pus containing streptococci and pneumococci. Under local anæsthesia, part of the fifth rib in the mid-axillary line was resected and drainage tubes inserted. There was profuse drainage. The child did not rally and died the same day.

No. 10.—Boy, eight years. Had influenza pneumonia, which for a little while seemed cleared up, but there was a return of temperature with pain in the chest, dyspnœa and loss of weight and strength. On admission to the hospital temperature was 101°,

pulse 140, respiration 30. The general appearance was that of toxicity. There was deficient expansion on the left side of the chest where also the percussion note was markedly impaired. Aspiration gave pus, which contained many streptococci. Hæmoglobin 75 per cent., red blood-cells 4,150,000; white blood-cells, 20,000; polymorphonuclears 87 per cent. Under local anæsthesia rib-resection was done with counter-drainage at a lower level. Much pus was obtained and three drainage tubes were inserted in the posterior axillary line. The patient continued to have septic temperature and pulse, with also some distention of the abdomen. This continued three weeks when the temperature increased as did also the distention and pain in the abdomen. The patient died one month after the operation.

A post-mortem examination was made and showed a diffused suppurative peritonitis; subsiding empyæma (left) and traumatic injury to the diaphragm.

Comparison with Other Statistics.—A comparison with other statistics may be made.

Reinhoff and Davison,[7] in a study of empyæma in children under two years of age in the Johns Hopkins Hospital from 1889 to June, 1927, report a mortality of 29.2 per cent. in twenty-four children treated by the open method with rib-resection, and 50 per cent. in twenty-two treated by trochar cannula. They are of the opinion that better results can be obtained by the use of one operation, the open thoracotomy in all cases.

Hart,[3] from the same institution, working on the patients in the twenty months following the above series and patients of all ages, used his closed method of tidal irrigation and suction. Fifty patients were treated, five died in the hospital, giving a 10 per cent. mortality.

Binney,[1] using a closed method, either trochar and cannula of the intercostal type or rib-resection and then closure with tight suturing of muscles around the tube, had a mortality in 100 cases of infants, children and adults, of 13 per cent. Twenty-one patients required a second operation.

Hudson[5] reporting eighty-six cases treated in children reports an 18.7 per cent. mortality in thirty-two cases treated by intercostal drainage and a 12.5 per cent. mortality in the remaining forty cases treated by the open rib-resection method. Of the twenty-one cases treated by the closed method fourteen later required a rib-resection. He concludes that rib-resection in children, as a primary operation in selected cases, or preceded by repeated aspiration or intercostal closed drainage during the synpneumonia stage is a valuable therapeutic procedure.

Farr and Levine[2] report 226 cases treated by the open method using rib-resection in 168 cases with thirty deaths, a mortality of 18 per cent. Intercostal incision with open drainage was employed in fifty-eight cases, with nineteen deaths, a mortality of 35 per cent.

McEnery and Brenneman[6] report a series of thirty-three children treated by repeated aspiration only. Three died, giving a mortality of 9 per cent. The average stay in the hospital was three and one-half months as contrasted with two and one-third months for children treated by them the previous year when they used the open method. They are guarded in their conclusions and do not recommend aspiration only as a routine for all cases in children.

CONCLUSIONS

(1) The 10 per cent. mortality, while it compares favorably with the mortality at other institutions where patients are treated similarly, or by different methods, still leaves plenty of room for improvement.

(2) The open method of treatment either by rib-resection or intercostal drainage after the diagnosis is established clinically, röntgenologically and by

diagnostic aspiration is an expedient method of treatment. This is particularly true in a hospital where the assistant and nursing staff are on a rotating system.

(3) It seems certain that too quick drainage is definitely more harmful than good. An acute pneumonic process should have been given ample time to subside. Again, in a very ill patient, where drainage is indicated, the decompression should be gradual, by aspiration, by closed intercostal tube drainage, and later, if indicated, by rib-resection with finger exploration of the cavity and insertion of open tubes.

(4) In an old primary empyæma where the patient has well compensated himself to the condition, not much is gained by anything else except partial rib-resection.

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ORBITAL MYOSITIS AND CHOKED DISC IN EXOPHTHALMIC GOITRE

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In a recent article Naffziger* has reported a case of progressive exophthalmos following thyroidectomy in which, on operation, the extra-ocular muscles were found to be greatly thickened, œdematous, and fibrous. A fragment of one of the affected muscles was excised and sectioned. On microscopical examination, the muscle fibres were found to be degenerated, and in part replaced by fibrous tissue, the interstitial tissue was œdematous, and contained focal accumulations of lymphocytes. Reports of similar cases, without histological notes on the extra-ocular muscles, are to be found in the literature. The most recent of these is by Stewens,† who has reviewed the literature up to date, and added one new case to those already reported. Common features of the cases previously reported have been that the exophthalmos continued to progress when the basal metabolism had been reduced to normal or that the exophthalmos was altogether disproportionate to the remaining degree of hyperthyroidism, that the exophthalmos was associated with orbital and conjunctival œdema, with paralyses of the extra-ocular muscles, and with choked disc and marked visual impairment.

Naffziger's discovery of what appears to be the specific histological lesion in this type of case raises the question as to whether or not the ordinary mechanism of exophthalmos in hyperthyroidism may be of a similar nature. In order to find the answer to this question, the orbital tissues of cases of exophthalmic goitre that had come to autopsy in the department of pathology of the Johns Hopkins Hospital were examined. In all, six cases were found in which sufficient orbital tissue had been preserved to make possible the histological study of the extra-ocular muscles. Of these five showed no lesions whatsoever in their extra-ocular muscles. These five were cases of ordinary hyperthyroidism showing no complications of interest in this connection. In the sixth case, lesions of the extra-ocular muscles were found similar to those described by Naffziger. The clinical history of this case was so remarkable as to merit brief report.

The patient was a white man of fifty-four years who came to the eye clinic of this hospital in May, 1924, complaining of pain, dimness of vision, and swelling in his left eye. His past history was without interest. Four months prior to his admission to the clinic, he had had a "cold in the head" accompanied by fever and malaise. One week later, he

* Naffziger, H. C.: Progressive Exophthalmus, Following Thyroidectomy, Its Pathology and Treatment. Annals of Surgery, vol. xciv, p. 582, 1931.

† Stewens, H.: Progredienter Exophthalmus nach Basedowoperation. Ueber Beziehungen zwischen Thyreoidea und Hypophyse. Zeitsch. f. Augenheilk., vol. lxxv, p. 137, 1931.

had become unconscious and had had numerous convulsions. After four days he had regained consciousness, but remained drowsy and complained of diplopia. A swelling developed over his left eye, and there was a purulent discharge from his nose. During the following two months, he improved somewhat, but later pain, lachrymation, swelling and tearing of the left eye had developed in increasing severity.

On admission to the hospital, the general physical examination revealed no constitutional disease. The patient was moderately undernourished, the thyroid just palpable; pulse, 80–90; temperature, normal; no tremor; white blood count, 7,900; hæmoglobin, 84 per cent.; urine, normal; blood Wassermann, negative. Ophthalmological examination by Dr. Alan Woods showed the vision of the right eye with correction to be 20/40, left eye 10/100. The left conjunctiva was congested, the eye slightly proptosed, with a swelling of the tissues above the eyeball, and limitation of upward and of inward rotation of the left eye. The pupils were equal but reacted sluggishly to light. The right optic disc showed blurred margins, the left was definitely protruding. X-ray of the

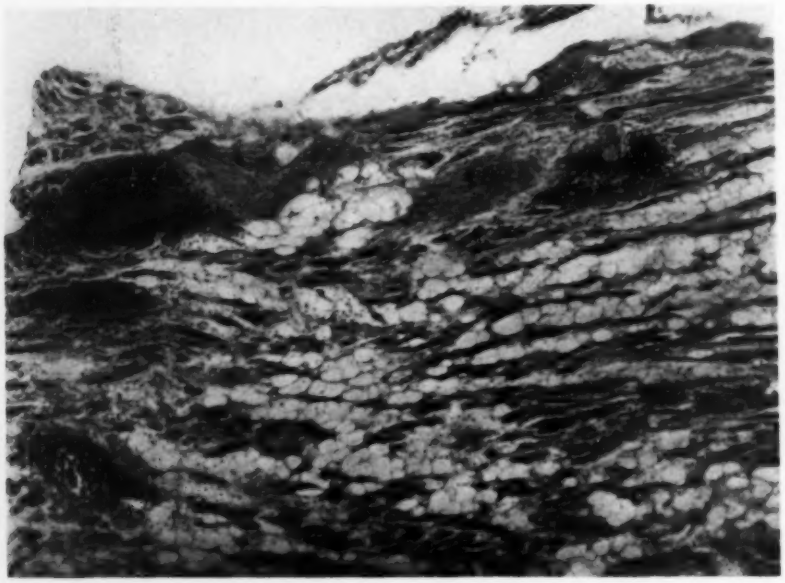

FIG. 1.—Orbital myositis in exophthalmic goitre.

sinuses and rhinological examination revealed no abnormality. The clinical impression of those seeing the patient at this time was that he had an orbital cellulitis, possibly an orbital abscess, possibly a brain abscess. Ten days after his first examination, it was for the first time noted that he had slight exophthalmos of the right eye. Lumbar puncture was suggested, but refused, and the patient left the hospital early in June.

He returned September 4, 1924, stating that his general health had improved since leaving the hospital until ten days previously when his left eye had become more inflamed, and his vision had begun to fail rapidly. He had lost much weight in the interval. His pulse was now 116, the thyroid definitely and symmetrically enlarged, white blood count 8,900. There was bilateral exophthalmos, the left eye being more prominent than the right. The left conjunctiva was congested and swollen. There was an ulcer of the cornea, and the appearance of an orbital cellulitis.

Basal metabolism was now found to be +60 per cent., but both Doctors Dandy and Woods, who were much interested in this case, thought that there was strong probability of an intracranial lesion, and Dr. Arthur Bloomfield was of the opinion that the hyperthy-

roidism alone could not account for the exophthalmos. The blood Wassermann was again found negative, spinal fluid showed no abnormality, X-ray of the skull was negative.

Three days after admission to the hospital, the patient became wildly delirious, and his heart began to fibrillate. Two days later, he developed bilateral acute glaucoma. In view of his maniacal state and fibrillating heart, no radical operation for the glaucoma could be performed, but a bilateral paracentesis of the anterior chambers was done resulting in relief from this symptom. The patient, however, rapidly went downhill with increasingly rapid pulse, continued delirium, cardiac failure, and died ten days after the operation, a little over eight months after the onset of his symptoms.

At autopsy, the thyroid was found to show the typical hypertrophy of hyperthyroidism. The other viscera were normal except for minor unrelated lesions. The brain, including the hypophysis, was normal both on gross and microscopical examination. No abscess was found in either orbit, and the gross appearance of the extra-ocular muscles was not abnormal. Recent review of the preserved histological slides of this case (Fig. 1) confirmed the above findings, but the sections of the orbital tissues revealed definite lesions of the type described by Naffziger.

There was no inflammatory reaction in the loose tissues of the orbits. The extra-ocular muscles of both orbits showed marked atrophy, with fibrosis of the fibre bundles. Many fibres had disappeared, and were replaced by fat. In the interstitial tissue, there were focal accumulations of lymphocytes at times presenting the appearance of definite lymph follicles with germinal centres. There was, however, no definite œdema either of the muscle fibres or of the interstitial tissue, or of the loose tissue of the orbits in general.

Discussion.—The literature on exophthalmic goitre is so voluminous, and contains the occasional reports of so many different lesions in various organs that it is extremely difficult to disentangle those lesions characteristic of the disease from those occurring in accidental association with it. Atrophy and fatty degeneration of the skeletal muscles have been frequently noted, and generally attributed to the wastage of the disease or to the atrophy from disuse. The typical lesions in the skeletal muscles, however, do not present the inflammatory character of the lesion in the orbital muscles in this case. Various changes have, also, been described in the heart muscle in hyperthyroidism, but none has been found to be characteristic of the disease.

It seems clear that the case just reported is allied to that reported by Naffziger, though, in Naffziger's case, the progressive exophthalmos followed after thyroidectomy, while, in the present case, the orbital trouble apparently preceded the hyperthyroidism by several months. It is of interest that no abnormality was found in the hypophysis, though Stevens attributes the symptoms in his case to a lesion in this gland. It seems, likewise, clear that the orbital myositis in Naffziger's case, and in the case just reported, is not a part of the ordinary picture of hyperthyroidism. The condition appears to be a separate disease entity in which lesions of the extra-ocular muscles are associated with abnormal function of the thyroid gland, but are not dependent upon an increased basal metabolism.

PERINEPHRITIC ABSCESS

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Although perinephritic abscess has been recognized since the time of Hippocrates it still presents interesting diagnostic and therapeutic problems. Any disease which defies clinical recognition in 32 per cent. of the cases and depends on post-mortem findings for diagnosis, certainly warrants study.[1] When the operative mortality for such a common disease reaches 19 per cent., which is the average for the five largest series reported, it is evident that, in many cases, we have failed to recognize the pathological processes until they are so far advanced that the patient is in a critical condition.

In view of the above considerations, we offer here a detailed study of thirty-two cases of perinephritic abscess, in the hope of stimulating interest in this subject.

Classification.—In 1839 Rayer[2] introduced the term "perinephritis" to designate an inflammatory reaction of the perirenal fat or adipose capsule. He suggested that these infections be classified according to their etiology as follows: (1) Primary perinephritic abscesses or those in which the infection develops in the perirenal fat *per se*; (2) secondary perinephritic abscesses or those arising from the kidney, the adjacent viscera or some distant primary focus. Since that time, several attempts have been made to classify perinephritic infections but the resulting nomenclatures have merely added to the confusion. In Israel's[3] anatomical classification the term "epinephritis" was reserved for inflammation of the perirenal fat, the term "perinephritis" for involvement of the fibrous capsule, and the term "paranephritis" for inflammation of the pararenal or retrorenal fat. While this classification is anatomically correct, these various types cannot be differentiated clinically and therefore the above classification has been discarded.

In more recent years Hunt,[4] Braasch,[5] and Habein[6] have carefully studied the etiology of perinephritic inflammation and they seriously doubt the existence of a primary perirenal abscess *per se*; they maintain that this condition always arises from some previous focus. The above-named authors suggest that if all such perinephritic infections are secondary to other systemic foci, they should be classified as being either of a renal or a nonrenal origin. This nomenclature permits the correlation of clinical and pathological findings and is not difficult of application.

Anatomical Considerations.—In order to obtain a clear concept of the pathogenesis of perinephritic abscesses we must be familiar with the anatomy of the kidney and the perinephrium.

The parenchyma of the kidney is completely covered by a thin, fibrous capsule from which delicate fibres pass into the renal cortex. When this fibrous capsule reaches the

hilum it extends along the renal vessels as a protective sheath. The kidney is embedded in a mass of fatty tissue, called perirenal fat, which is relatively thin about the upper half of the kidney, accumulates at the hilum, is fairly abundant at the lower end, and is thickest over the posterior aspect at the lower pole. As the function of this perirenal fat is entirely protective, the reason for its anatomical position is evident. This fatty capsule is not present at birth, and is more or less deficient until puberty. Miller[7] maintains that it varies in amount in individuals and rapidly disappears during emaciation.

The kidney and perirenal fat are enclosed in a sheath of fibrous tissue, which is continuous with the subperitoneal fascia and is called the fascia of Gerota (fascia renalis). At the outer border of the kidney the fascia is divided into an anterior and posterior layer. The anterior layer is carried in front of the kidney and its vessels, and is continuous over the aorta with the corresponding layer on the opposite side. The

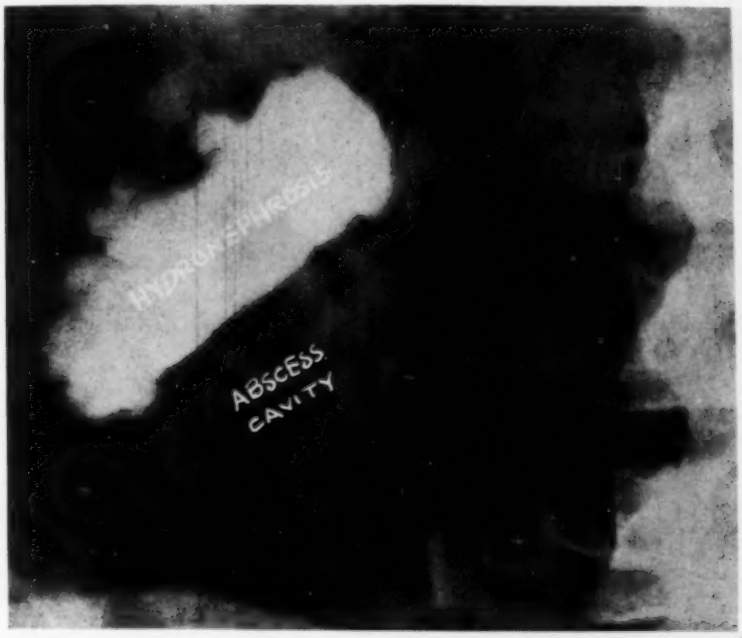

FIG. 1.—Röntgenogram showing a large hydronephrosis with a visualization of a coëxisting perinephritic abscess.

posterior layer extends inward behind the kidney and fuses with the fascia of the quadratus lumborum and psoas muscles. Above and laterally, the sheath joins the fascial lining of the diaphragm and transverse muscles respectively. Below, the two layers remain separate for a short distance and then fuse.

These fascial coverings of the kidney are very important as they determine the direction in which a perinephritic abscess may extend. Small fibrous trabeculæ join the fascia renalis to the true renal capsule by traversing the perirenal fat. The adipose tissue is practically avascular, having a very meagre blood supply.

According to Gerota[8] and Zuckerhandl,[9] the lymphatic vessels of the kidney form three plexuses; one in the renal parenchyma; one beneath the true renal capsule, and a third in the perinephric fat. The subcapsular and fatty tissue plexuses anastomose very freely, thus affording a means of spreading infection. The lymph-vessels of the kidney and the perinephrium drain into the lateral aortic nodes which also receive drainage from the lower genito-urinary tract and bowel.

From the foregoing brief anatomical review, we find (1) that the perinephric tissue

is encased in a fibrous capsule; (2) that this area has a low resistance to infection owing to its meagre blood supply, and (3) that lymphatics of the adipose tissue anastomose with those of the kidney, thus offering a route for bacterial invasion.

Etiology.—Pyogenic bacteria reach the perirenal tissues by (*a*) direct extension from an infected kidney or adjacent tissue, (*b*) by lymphatic dissemination from a primary focus, or (*c*) by hæmatogenous metastasis. At times we are able to trace the mode of infection but in many cases our studies are inadequate to reveal the primary source and we term the infection cryptogenic.

The fact that renal disease can produce perirenal infection is well established, pyonephrosis, nephrolithiasis, renal tuberculosis and cortical abscess being the most common offenders in this regard. (Fig. 1.) In 230 cases of perinephritic inflammation, renal disease was found by Kuester[10] in 26 per cent.; by Braasch[5] in 55.4 per cent.; by Hunt[4] in 44.6 per cent.; by Miller,[7] 20 per cent.; by Albarrans,[11] 50 per cent.; and by Israel,[3] 79 per cent. Guiterras[12] is very emphatic in asserting that practically all infections of the perinephrium arise from the kidney; in his series of fifteen cases a definite renal disease was present in fourteen. In our series of thirty-two cases the kidney was involved nineteen times. (Table I.) However, all the nephritic infections were not primary in the kidney but some were secondary to systemic foci.

TABLE I

Types of coëxisting renal disease found in our series

Pyonephrosis	10
Nephrolithiasis	3
Tuberculosis	1
Carbuncles	1
Multiple cortical abscesses	2
Duplex kidneys with infection	2
Condition not determined	13

When the kidney becomes infected, whether the infection is due to calculi, hydronephrosis, or injury; or whether it is ascending or hæmatogenous, pyonephrosis may result. The parenchyma is invaded, multiple abscesses are formed, and in many instances the cortex is studded with small localized areas of inflammation. These suppurative cortical areas may rupture and produce a perinephritic infection. Hunt[4] maintains that most perirenal infections arising from primary peripheral lesions such as felons, carbuncles, dental infection, osteomyelitis, and parotitis, are preceded by cortical abscesses of the kidney. Richardson[13] collected 108 cases of perirenal abscess due to metastatic renal infection and found that in thirty-three cases a renal carbuncle preceded the inflammation of the perinephrium.

It is a common experience to open a perinephritic abscess and be unable to demonstrate any communication with the kidney. Even the closest scrutiny may fail to reveal a ruptured cortical abscess or a fistulous tract to the interior of the kidney. Miller[7] believes that the infection spreads from the kidney

to the perinephrium by means of the lymphatics, as Zuckerhandl,[9] and Gerota[8] have demonstrated an anastomosis between the subcapsular and subserous lymphatics.

Although we agree that renal disease causes perirenal infections, it must be remembered that the incidence of perirenal infections is not very high. In 2,680 nephrectomies performed at the Mayo Clinic, perinephritic abscesses were demonstrated in only 1.5 per cent., and all of these cases represented advanced renal lesions. All cortical abscesses do not rupture and produce inflammation in the perinephrium but many of them subside spontaneously. Renal tissue has regenerative power as is evidenced by the healing of cortical abscesses following simple incision and drainage of the perirenal abscess.

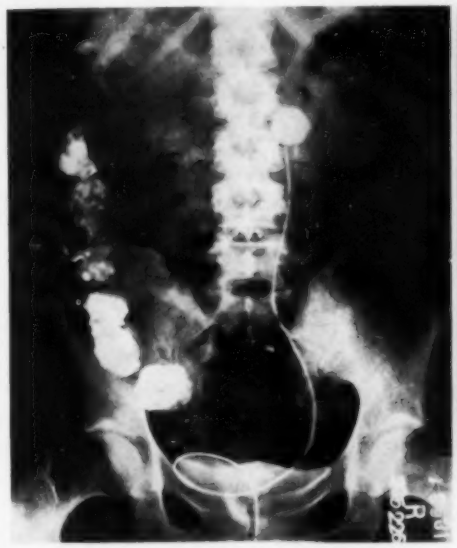

FIG. 2.

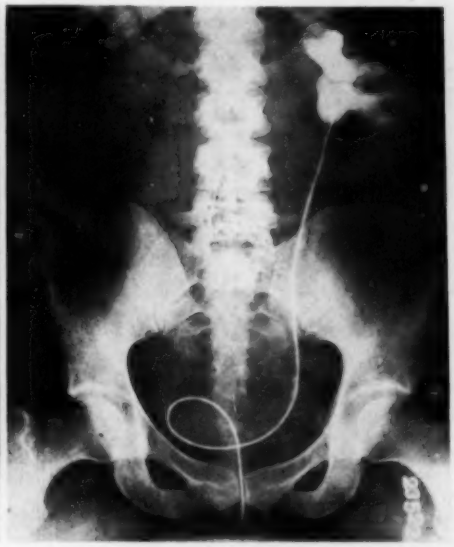

FIG. 3.

FIG. 2.—Flat plate of kidney showing a calculous pyonephrosis. At operation an associated perinephritic abscess was found which did not show in the röntgenogram. Barium is visualized in the large bowel as the result of gastro-intestinal studies.
FIG. 3.—Pyelogram made in above case showing a calculous pyonephrosis; no evidence of the coëxisting perinephritic abscess is seen.

At autopsy we have found renal abscesses in various stages of formation and regression. Some were large and necrotic, others were small and well localized; some were undergoing the process of autolysis and others were being absorbed and the damaged renal parenchyma replaced by cicatricial tissue.

In performing nephrectomies for renal disease we often encounter badly damaged kidneys embedded in healthy adipose tissue, indicating that not all renal infection extends to the perinephrium. Probably carbuncles of the kidney give rise to a greater number of perinephritic infections than any other single lesion but are difficult to demonstrate.

Perinephritic infection due to extrarenal disease may result from suppurative foci in any part of the body. Systemic diseases such as appendicitis, cholecystitis, ulcerative colitis, osteomyelitis, pneumonia, influenza and typhoid,

or local infections such as felons, boils, furuncles, and abrasions, may all be precursors of perirenal inflammations. Hunt[4] collected 160 cases of perinephritic abscess, in 85 per cent. of which the primary source was a peripheral lesion. Harzbecker[14] had 32, Birdsal[15] 11, Rhen[16] 6, and Richardson[13] 108 cases of perinephritic inflammation which were directly due to a metastatic peripheral infection.

Miller[7] maintains that the lower genito-urinary tract and bowel may be a source of infection before the kidney becomes involved. He points out that some of the lymphatics of the bowel, prostate, bladder, urethra, and uterus, drain into the lateral aortic nodes, which also receive lymph-vessels of the perinephrium, thus offering a direct path for bacterial invasion. In support of his contention, we find perinephritic abscesses reported as sequelæ of an abortion (Murphy[17]); acute orchitis (Jordan[18]); following gonorrhœa (Israel,[3] Ransohoff,[19] Jaffe,[20] Hagner[21]); and post-partum as in Horsley's[22] three cases. In one of our cases a dilatation and curettage was performed for uterine bleeding and retained placenta. Two weeks later the patient complained of pain over the right kidney and at operation a large perirenal abscess was found. While Miller[7] maintains that these abscesses are the result of lymphatic dissemination it seems logical to infer that many of them may be of a hæmatogenous origin.

Bacteria.—Any pathogenic bacteria gaining entrance to the perirenal tissue are capable of setting up an infection providing they are given the proper environment. Staphylococcus, streptococcus, gonococcus, pneumococcus, tubercle bacillus, typhoid bacillus, *Bacillus coli* and Actinomyces have been reported. If the abscess is secondary to metastatic infection, generally staphylococci will be found; if the abscess is secondary to simple pyonephrosis then *Bacillus coli* may be present and in some cases mixed infections are encountered. The following table indicates the various types of organisms which were encountered in this series.

TABLE II

Organisms Cultured from Perirenal Pus

Staphylococcus	9
Bacillus coli	3
Streptococcus	2
Bacillus coli and streptococcus	1
Bacillus coli and straphylococcus	1
No cultures	15
Negative culture	1

Age and Sex Incidence.—Perinephritic abscess may occur at any period of life, but is usually found in individuals between the ages of twenty and forty years. In our series, the youngest patient was three months old and the oldest seventy-four years; the average age was thirty-four and a half years. Infections of the perinephrium are uncommon in children because the perirenal fat does not become fully developed until puberty. However, Campbell[1] reports a case of a child in whom a staphylococcic infection of the

thumb developed seven days after birth; the felon was incised and six days later the child died. Autopsy revealed multiple cortical abscesses of both kidneys with an early perinephritic abscess on one side. Table III represents the age distribution in our series.

TABLE III

Under 20 years	1 case
20 to 40 years	15 cases
40 to 60 years	11 cases
60 to 80 years	2 cases
Age unknown	3 cases
Youngest	3 months
Oldest	74 years
Average	34.5 years

Perirenal infections are more common in men than in women, perhaps on account of the fact that in men renal trauma is more common due to the strenuous character of their work. In our series of cases seventeen occurred in males and fifteen in females.

Trauma.—Trauma is an important predisposing factor in perirenal infection. The local resistance of the injured tissue is lowered, thus permitting bacterial invasion. Brewer injected bacteria into the blood stream of animals but was unable to produce perinephritic abscesses until he conceived the idea of traumatizing the perirenal tissues. The more frequent occurrence of right-sided infection is attributed to the lower position of the right kidney which renders it more liable to injury. The association of calculi with renal and perirenal infection is perhaps due to persistent injury which lowers the resistance of renal tissue.

Many cases have been reported in which the perinephritic inflammation was due to an extravasation of urine into the adnexal tissue as a result of operative injury to ureters or renal pelves. In one of our cases two pelviolithotomies had been performed for recurring stones. Following the second operation a perinephritic abscess developed with a protracted draining sinus. Table IV shows the various etiological factors which we considered to be responsible for the existing perirenal inflammation.

TABLE IV

Factors concerned in the production of perinephritic infections

Infection	
Boils	4
Dental abscesses	2
Osteomyelitis tibia	1
Acute prostatitis (following massage)	1
Carcinoma prostate with abscesses	1
Chronic appendicitis	1
Influenza	1
Erythema nodosum	1
Dilatation and curettage for retained placenta	1

Trauma

Injury to perirenal tissue	8
Primary renal disease	
Pyonephrosis	2
Nephrolithiasis	2
Tuberculosis (renal)	1
Actinomycosis	1
Not determined	5

Symptoms.—Onset—The mode of onset varies, depending upon whether the perinephritic inflammation is of renal or extrarenal origin. In those cases in which the condition is associated with chronic renal disease such as pyonephrosis or calculi, the onset is insidious and the formation of the abscess

FIG. 4.—Röntgenogram showing a calculus in right kidney associated with pyonephrosis. At operation a coëxisting perirenal abscess was found.

is generally indicated by a progressive increase in the intensity of such symptoms as fever, chills, pains, and generalized malaise. In those cases in which the condition is the result of metastatic infections, whether local or general, the onset is frequently acute and sudden, with rigor, malaise, and generalized reactions which closely simulate the symptoms of a systemic infection. In three of our cases the onset was so sudden and the prostration so profound that we made the diagnosis of influenza; however, in three days the localizing symptoms suggested the presence of a perinephritic inflammation which was confirmed by operative procedures.

In the case of a perinephritic abscess of metastatic origin, the primary focus may be completely healed before the symptoms have progressed sufficiently to make a diagnosis. This latent period often confuses the diagnos-

tician as he is unable to find any relationship between an existing perirenal infection and a carbuncle which healed two months previously. Occasionally a perinephritic inflammation develops simultaneously with the peripheral lesion and is probably the result of an infected embolus being carried to the perinephrium.

Chills and Fever—Chills have always been considered as an initial symptom in perinephritic infections; however, in but twelve of our cases could we elicit such a history, and in these the infection was usually of a metastatic origin. The number of chills varied from one to twenty-three per day, and in one case the chills had been present for two months prior to the admission of the patient.

A fébrile reaction is the most constant symptom, and was present in all of our cases. The fever is of the intermittent type and varies between a marked hyperpyrexia and a moderate rise of temperature. When the fever is associated with chills, the patient usually has profuse drenching sweats. It is very interesting to note the rapid descent of the fever which sometimes accompanies the incision and drainage of the perirenal abscess.

A chill followed by a marked fébrile reaction, associated perirenal pains, and tenderness, is very suggestive of a perinephritic infection.

Pain—Pain is the one symptom for which the patient seeks relief. The pain usually begins as a sense of fullness beneath the twelfth rib posteriorly, gradually increasing in intensity until it becomes a dull, deep-seated continuous pain, which is almost unbearable. In only three of our cases were the pains sharp and stabbing and in four cases they were paroxysmal. The pain is always accentuated by motion because of the inflammatory reaction and spasm of the psoas and erector spinæ muscles. Most patients obtain relief by heat; morphine is seldom required.

The pain is usually localized to the costovertebral angle but may be referred to the testes, knees, hips, or abdomen. One patient complained of intense pain in the right knee but negative orthopedic examinations resulted in further investigation which revealed a small perinephritic abscess. In the case of two patients the pain was entirely abdominal, being referred to the right hypochondrium and associated with tenderness over the gall-bladder. On palpation, a deep indefinite mass could be felt which was thought to be a distended gall-bladder. An exploratory laparotomy revealed a normal gall-bladder overlying a large retroperitoneal abscess which completely surrounded the kidney.

Urinary Symptoms—It is interesting to note that in only 10 per cent. of our patients were urinary symptoms noted and in each case some associated renal disease was present such as pyonephrosis, calculus, or renal tuberculosis. Frequency, urgency, dysuria, and nocturia were the oustanding symptoms in those cases in which associated renal disease was present.

Urinary studies showed that in 55 per cent. of the patients the urine was normal except for the presence of albumin. The albuminuria might have been an expression of the fébrile reaction rather than an indication of renal

or perirenal infection. In all cases in which the urine was abnormal a definite kidney disease was present. In one case the kidney contained multiple cortical abscesses and the urine was normal. In this series we found that the urinary changes offered no aid in the diagnosis of perinephritic abscess but were of some value in determining the physical status of the kidneys. (See Table V.)

Postural Deformities—A thorough physical examination is essential to establish the diagnosis of perinephritic abscess. Peculiar postural deformities are often noted, especially in children, and may be the first sign. In five of our cases the patients could not extend the isolateral thigh because the abscess produced a spasm of the iliopsoas muscle. They walked with a peculiar flexion deformity, and when in the recumbent position the thigh was semiflexed.

A slight lumbar scoliosis can often be detected, the arch being toward the normal side; or a slight swelling or fullness in the costovertebral angle may be noted.

Rigidity and Tenderness—Abdominal rigidity was present in 50 per cent. of our cases and was suggestive in an additional 10 per cent. The rigidity may be localized to the musculature of the loin or referred to the anterior abdominal wall. Reference has been made to two cases in which the rigidity and tenderness of the right hypochondrium led to an erroneous diagnosis of gall-bladder disease.

Tenderness is usually present and varies from a slight sense of soreness to excruciating pain when the slightest pressure is exerted over the inflamed perinephrium. Brewer[23] considers tenderness to be the pathognomonic sign of a hæmatogenous infection of the kidney. Miller[7] emphasizes that the fixed point of greatest tenderness is over the fascial triangle of Lesshaft. In all but two cases we were able to elicit tenderness on deep palpation. However, in avirulent infections the tenderness develops very slowly and in some cases cannot be demonstrated.

Mass—Careful inspection sometimes reveals the fact that the lumbar hollow is replaced by a slight fullness or bulging. In 38 per cent. of our cases we were able to demonstrate a definite tumefaction. The mass may be firm and indurated suggesting a perirenal tumor, or it may be soft and fluctuant, suggesting the presence of fluid. Large perinephritic abscesses may be present without signs of tumefaction. Guiterras[12] was unable to demonstrate fluctuation in an abscess, which on operation yielded three quarts of pus.

If the abscess lies anterior to the kidney, a retroperitoneal swelling may be produced which may be easily mistaken for an intra-abdominal tumor. In two such cases we thought the perirenal mass was a distended gall-bladder. In another case we were able to palpate a large, firm, indurated mass adjacent to the cæcum which suggested an appendiceal abscess. As the patient's urine was loaded with pus, a urological study was made which resulted in the diagnosis of pyonephrosis with a perinephritic abscess. In performing a left nephrectomy we encountered a large perirenal abscess, which had dissected

its way across the vertebræ and great vessels, over to the right iliopsoas muscles and then became localized to the retrocæcal area.

The difference between the two sides can be accentuated by examining the patient first in the sitting and then in the standing position. If the abscess is large, the entire iliocostal curve may be obliterated. Palpation sometimes produces pitting of the tissue due to the local inflammatory œdema. Deep-seated tumors which cannot be palpated may often be outlined by percussion as the inflammatory mass produces a local increase in dullness.

Blood changes—Leucocytosis is usually present, and in only five cases of avirulent infection was it normal, the average count being 17,000. In six

FIG. 5.

FIG. 6.

FIG. 5.—Pyelogram showing actinomycosis of kidney and perirenal tissue; the pyelogram fails to show any evidence of infection.

FIG. 6.—Pyelogram showing duplex kidney with hydronephrosis of lower pole, associated with perinephritic abscess. The abscess was drained and a heminephrectomy performed.

cases in which the septic course suggested a bacteremia, blood cultures were made, all of which were negative. In those cases in which changes in blood urea, uric acid, creatinin, and serum proteins were noted associated renal disease was present, which accounted for the disturbance.

Cystoscopy and Röntgenography.—Cystoscopy with ureteral catheterization, differential renal function tests and röntgenographical studies should always be made as they occasionally reveal the existence and degree of associated renal disease. In our series, routine cystoscopic and pyelographic studies demonstrated six cases of pyonephrosis, three of nephrolithiasis, two of ureteral stricture, two of duplex kidneys with infection, one of renal and vesical tuberculosis, and four of inflammatory cystitis which were complicating an anticipated perinephritic abscess.

In this series, pyelographic studies were made in the case of twenty patients and in only four cases were we able to make a definite diagnosis of a perinephritic infection. In each of these four cases we were able to demonstrate either a renal or a ureteral fistula communicating with the abscess. However, in three instances the röntgenologist made a definite diagnosis of perinephritic abscess which additional studies proved to be erroneous.

Röntgenograms of the bladder, ureters, and kidneys made on a flat plate often contribute evidence which aids in diagnosis, and are especially valuable in eliminating diseases which are confused with perirenal infection. We have records of ten cases which were referred to the clinic by local physicians who had made a presumptive diagnosis of a perinephritic abscess. X-ray examination of the spine demonstrated advanced arthritis of the vertebræ which was responsible for their pains. A flat plate may show a high fixed diaphragm suggesting a subdiaphragmatic abscess or an empyema of the chest and thus help to clarify the diagnostic puzzle.

FIG. 7.—Intravenous urogram of a pyonephrotic kidney associated with a perirenal abscess which was not demonstrated by the urogram.

Alexander,[24] Beer,[25] and Lipsett[26] believe that the most valuable röntgenological finding is the obliteration of the lateral border of the psoas muscle by the overlying abscess. Campbell concurs in this view. Beer[25] also emphasizes the existence of a lumbar scoliosis due to the marked spasticity of the iliopsoas and erector spinæ muscles, the spinal curvature being away from the affected side. Nichols, of the clinic, maintains that a fluoroscopical study is perhaps the most valuable single help in determining the presence of pus in the perinephrium by demonstrating a fluid curve. While cystoscopical and röntgenographical studies are valuable in determining the presence of associated renal disease it is seldom that sufficient direct evidence is found to make a diagnosis of perinephritic abscess *per se*, as demonstrated in Figs. 1, 2, 3, 4, 5, 6, and 7.

In a symptomatic review we found that fever, pain, leucocytosis, tenderness and the presence of a "lumbar mass" were the most reliable diagnostic findings. We should also attempt to determine whether the primary focus of the perirenal infection lies in a disease of the kidney, spine, abdominal viscera, or peripheral infection and we should attempt to eliminate it. To incise and drain an abscess without correcting the cause is to apply palliative therapeutics. The reason why so many perinephritic infections have been termed idiopathic is probably due to incomplete studies.

Course.—The sequelæ which may result from a perinephritic abscess are

many. As all abscesses tend to invade adjacent tissue it is not surprising to find perirenal infections extending to other organs. In Kuester's collected series of 230 cases, thirty-four ruptured in surrounding viscera as follows:[10] Into pleura and bronchi, 18; intestine, 11; peritoneal cavity, 2; bladder and vagina, 2; bladder, 1.

If the pus burrows through the external arcuate ligament of the diaphragm and enters the pleural cavity, an empyema results. It may extend into a bronchus in which case the patient expectorates purulent material. Miller[7] does not believe that all empyemas result from diaphragmatic perforation but some arise from ascending lymphatic infection.

The abscess may rupture into the loin and form a cutaneous sinus by perforating the tissues of Petit's triangle. It may perforate the walls of the intestines and cause a thin purulent diarrhœa. We have observed one nephrocolic and one nephroduodenal fistula resulting from a perinephritic infection. The pus surrounding the kidney may penetrate the renal pelvis or the ureter, in which case a sudden profuse pyuria develops. Two patients reported to the clinic complaining of an intense pyuria and pyelographic studies demonstrated that one patient had a renal-perirenal fistula and the other a ureteral-perirenal fistula. All four cases of fistula are to be reported in greater detail at a later date. In those cases in which a perirenal abscess ruptures into an adjacent organ there is an immediate decrease in the size of the perinephric mass and the new symptoms depend on the viscus involved.

The inflammation of the perinephrium may follow any of the various muscle planes resulting in a psoas, lumbar, obturator or inguinal abscess.

It is conceivable that a perirenal abscess can be absorbed and reparation made. All chronic perinephritic inflammations do not require surgery but some subside spontaneously. All surgeons are acquainted with the firm, dense fibrous adhesions which are encountered in the perinephrium indicating that some preceding inflammatory reaction has become cicatrized. Guiterras[12] reports a case of his own and cites one of Albarrans' in which a known perirenal abscess had been absorbed. Neff[27] and Hunt[4] suggest that some renal carbuncles heal. In two cases we made a diagnosis of perinephritic inflammation but the patient refused immediate operative intervention. Three weeks later a simple incision was made and we encountered a subsiding inflammatory reaction; cultures showed the presence of *Bacillus coli*. However, the resistance of the perirenal tissue was so good that a spontaneous healing was well advanced when we intervened.

Differential Diagnosis.—Conditions which require differentiation from perirenal abscesses are: Traumatic rupture of the kidney, pyonephrosis, nephrolithiasis, renal and perirenal tumors, lumbar arthritis, lumbar hernias in Petit's triangle, retrocæcal appendicitis, subdiaphragmatic abscess, gallbladder disease and tuberculosis of the spine and hip. However, a chronological history together with a complete physical and urological examination, corroborated by röntgenological studies, usually permits a correct diagnosis.

Campbell[1] emphasizes the difficulty of making a diagnosis by showing that

out of eighty cases of perinephritic abscess, twenty-six were not recognized until autopsies were performed. In two cases he made a diagnosis of an intra-abdominal lesion, and in two other cases he suspected acute appendicitis but on exploratory laparotomy he found a perirenal abscess. In one case in which he believed a perinephritic abscess to be present operation revealed gall-bladder disease. We had similar experiences for in two cases we opened the abdomen for cholecystitis and found a perinephritic abscess. In a third case a diagnosis of hæmorrhagic renal infarcts was made but on operation a perirenal abscess was encountered. In one patient an extensive infection of the perinephrium was discovered post-mortem which could not be detected clinically in spite of complete urological examination.

Treatment.—In uncomplicated cases of perinephritic inflammation liberal incision and drainage is the treatment of choice, and the earlier the operative intervention, the better the prognosis. On two occasions we explored the perinephrium and found a definite induration of the tissues with a marked inflammatory reaction but no evidence of suppuration; drains were inserted and twenty-four hours later a purulent discharge appeared with staphylococcus grown from the culture. From the above observations it will be seen that early treatment minimizes tissue destruction.

Conservative renal surgery is the method of choice and it is surprising to see how rapidly a diseased kidney will recuperate if given an opportunity. One patient had a duplex kidney with a pyonephrosis of the lower half; a large perirenal abscess surrounded the lower pole. The abscess was drained and a hæminephrectomy performed, and the patient made an uneventful recovery; repeated urological examinations indicate a normal functioning kidney at the present time.

In cases in which a perinephritic abscess has been caused by a renal carbuncle, it has been customary to perform a nephrectomy but recent studies suggest that a more conservative procedure might be employed. Neff[27] recently reported a series of cases in which he enucleated renal carbuncles and after repeated urological examinations he found that the diseased kidneys regained a good function. (Table V.) He firmly believes that unless the kidney cortex contains multiple carbuncles conservative surgery is indicated. Hunt[4] intimates that many infections of the renal cortex subside if the perinephritic abscess is drained. If urological studies show the affected kidney to be badly damaged, then a nephrectomy can be performed at the primary operation. However, many patients are so extremely ill that simple incision and drainage of the perinephritic abscess is all they can tolerate. After the general condition of the patient has improved, a secondary nephrectomy can be performed if it is indicated. In our series, incision and drainage was employed in nineteen cases followed by good functional recovery, primary nephrectomy with drainage in eight cases, and incision and drainage followed by a secondary nephrectomy in three cases; in one case hæminephrectomy was performed. It seems that conservative measures are indicated if at all possible.

TABLE V

Urinary Symptoms and Findings

Symptoms

Burning	10
Urgency	5
Hæmaturia	1
Nocturia	8

Urinalysis

Red blood cells	4
White blood cells	14
Albumin	29
Organism by smear and culture	12
Normal except for albumin	16
Not reported	2

In all cases where pus and organisms were found there was associated renal disease.

Prognosis.—The prognosis in cases of perinephritic inflammation depends on the duration of the infection and the general condition of the patient. Immediate operative intervention offers the best prognosis. In Kuester's[10] review of 230 cases the operative mortality was 34.6 per cent., in Campbell's[1] 20.4 per cent., in Guiterras'[12] 20 per cent., in Miller's[7] 14.3 per cent., and in Hunt's[4] 6.6 per cent. In our series of thirty-two cases, in all of which operation was performed, there were two deaths, a mortality of 6.2 per cent. In our follow-up examinations, twenty-five patients were still living and free of symptoms, three had died of "kidney disease" within two years after operation and two of intercurrent infections.

Complications.—The only complications which we encountered were two cases of severe secondary hæmorrhage in which a blood transfusion was required, and one secondary operation to close a chronic renal sinus. Most of the patients had a cutaneous sinus that drained for an average of five weeks and one for as long as eight months. General medication, a healthful environment and local antiseptics facilitate healing.

SUMMARY

A clinical study of thirty-two cases of perinephritic abscess has been reported in this paper.

Etiologically, the disease may be of a renal or a nonrenal origin. Pyonephrosis, nephrolithiasis, tuberculosis, and carbuncles are the most common associated renal diseases, and bacterial metastases from peripheral and systemic foci of infection produce the nonrenal variety of perinephritic infection. Fever, pain, leucocytosis and tenderness over the costovertebral angle are the most significant symptoms and these together with a carefully elicited history often lead to a correct diagnosis.

Urinalysis is of some value in demonstrating associated renal disease but is of little importance in diagnosing perirenal disease of a nonrenal origin.

Röntgenography is useful in demonstrating the presence of coëxisting diseases, but a diagnosis of perinephritic abscess *per se*, is seldom made by this method.

The treatment is surgical and is governed by the condition of the patient, the location of the abscess, the presence of associated diseases and by complications.

Conservative measures should be employed whenever possible.

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TUBERCULOSIS OF THE UPPER SEGMENT OF A DUPLICATED KIDNEY*

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Duplication of the renal pelvis and ureter, either completely or partially, represents one of the commonest congenital anomalies of the genito-urinary system. Although cystoscopical and pyelographical studies acquaint the examiner with the presence of such a condition, it may first be discovered at operation. (Fig. 1.) Duplicated kidneys are subjected to pathological changes similar to those of the normally developed kidneys. Since tuberculosis attacks the kidney more frequently than any other portion of the genito-urinary system, one would expect tuberculosis of the duplicated kidney to occur. However, tuberculosis is rarely seen at a stage when only one segment of the kidney has become involved. The following report is representative of such a case.

A woman, aged forty-seven years, registered at The Mayo Clinic June 3, 1931, with the complaint of pain in the right upper part of the abdomen and back of thirteen years' duration. Fifteen months before she came to the clinic, dull suprapubic distress and moderate dysuria had developed. Intermittent hematuria had occurred for two months following cystoscopical examination. She had not lost weight recently.

The right kidney was palpable and tender. There were thirty milligrams of urea in each 100 cubic centimetres of blood, and the concentration of hæmoglobin was 81 per cent. Röntgenograms of the thorax were negative. A catheterized specimen of urine contained pus, graded 4. Cystoscopical and retrograde pyelographical studies disclosed complete duplication of the right ureter and renal pelvis, without crossing of the ureters. Urine from the upper segment contained pus, graded 4, and function was markedly reduced. The lower segment functioned normally, and its urine was not infected. The left kidney responded normally to functional tests and produced clear urine. Ureteral catheters passed through both ureters without obstruction. Koch's bacillus was not demonstrated.

June 16 exposure of the right kidney revealed infection of the upper segment, involving the cortex (multiple small punctate tubercles) and the upper portion of the corresponding ureter. Right heminephrectomy was performed. (Figs. 2 and 3.) The pathologist reported tuberculosis, whereupon the remaining half of the right kidney was removed. Tuberculosis was not demonstrable grossly or microscopically in the lower portion. Convalescence was uneventful and the patient was dismissed on the sixteenth day after operation, at which time the wound was practically healed.

Braasch and Scholl[2] reported 144 cases of duplication of the renal pelvis and ureter observed in The Mayo Clinic; in six of the cases nephrectomy

* Submitted for publication September 15, 1931.

was performed for tuberculosis. Although the tuberculosis was confined mainly to one segment, in four of the cases, however, microscopical examination revealed that the tuberculous process had spread to the adjacent, apparently healthy segment.

Perman,[4] in 1923, and Boeckel and Franck,[1] in 1926, each reported a case similar to that presented here. In both cases tuberculosis was confined to the upper segment of a double kidney. In presenting their case, Boeckel

FIG. 1.—Retrograde pyelogram of right kidney. Complete duplication of pelvis and ureter may be observed.

and Franck[1] called attention to Franco's[3] thesis, published in 1922, in which he reviewed from the literature thirteen cases of similar type, in six of which the condition was found at necropsy, and in five at the time of operation. In only two cases was it possible to make the diagnosis by cystoscopical examination and catheterization of the ureters. Microscopical examination to determine the presence or absence of tuberculosis was not made in all of the cases noted by Perman[4] in the literature. Papin, in discussing Boeckel and Franck's case, related having operated with Legueu on a patient who had

advanced tuberculosis in one kidney and early infection by Koch's bacillus in one segment of the other kidney which was duplicated. Heminephrectomy on the duplicated kidney was followed by nephrectomy of the other. The patient recovered and remained in good health.

If one portion of a duplicated kidney is tuberculous, the other segment seems usually to be involved, and nephrectomy the operation of choice. On the other hand, if the process can be proved definitely to involve only one

Fig. 2

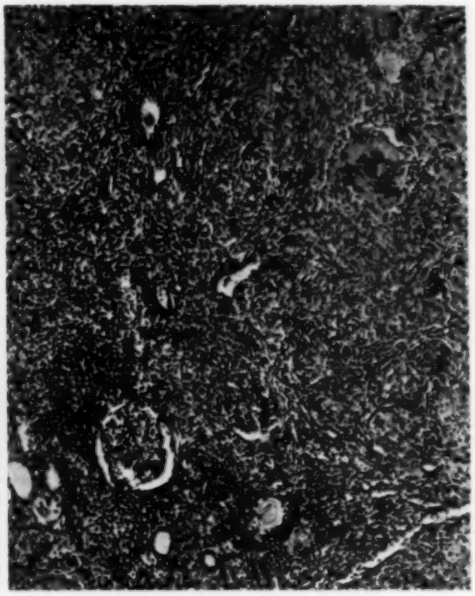

FIG. 3

FIG. 2.—Kidney with duplicated pelvis. Upper segment shows early involvement with tuberculosis; the lower segment is free from tuberculosis.

FIG. 3.—A specimen taken from the upper segment of a duplicated kidney that shows a typical tuberculous process.

segment, heminephrectomy may be done if the affected segment is accessible and has its individual blood supply.

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MALIGNANT TUMORS OF THE KIDNEY IN INFANCY AND CHILDHOOD *

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Bland Sutton has stated that complicated glandular organs such as the kidney and prostate are prone to develop sarcoma at all ages but more particularly in the early years of life. Certainly the kidney is the most frequent site of malignant disease in the first decade, between 20 per cent. and 25 per cent. of all malignancies occurring in this region. Although the commonest of all malignancies in childhood, it is yet a rare disease, and reports in the literature of limited series of cases have dealt largely with the pathogenesis and pathological aspects of these interesting tumors. From the larger collected series it is difficult to obtain definite data regarding the operability, the operative mortality and the expectation of cure in this seemingly discouraging group of cases. It is with the hope of throwing some light on these points rather than attempting to evaluate the theories of pathogenesis, that this series of cases has been considered.

During the past twenty-one years there have been approximately 22,000 admissions to the surgical wards of the Children's Hospital, Boston, and in the same period forty-one instances of renal neoplasm have been recorded. In the same length of time ten cases of neuroblastoma of the adrenal, five of ovarian and four of bladder malignancy appear in the records. Renal neoplasm in the child is probably encountered with one-sixth the frequency as in the adult. In our series of forty-one kidney tumors, the pathological diagnosis was embryomatous mixed tumor in thirty; in seven, various pathological diagnoses, including sarcoma, hypernephroma and malignancy of epithelial origin were given; and in four cases, though three had been subjected to exploratory operations and one to nephrectomy, no pathological report was available. It is probable that if the gross specimens were still available, further study would show that many, if not all of the seven cases in which the pathological diagnosis was unquestionably based on the preponderance of one type of cell in the given tumor, would be reclassified as embryomatous mixed tumor by the identification in other portions of the specimen of embryonic gland tubules, smooth or striated muscle fibres, cartilage or other elements characteristic of these neoplasms.

Fraser has concisely summarized three of the four principal theories of pathogenesis of the mixed tumors:

(1) That their origin is due to inclusions of Wolffian body tissue which has become displaced and persists among the cells of the developing kidney or metanephros. (Birch-Hirschfeld.)

* Read before the Southern Surgical Association, December 9, 1931.

(2) That aberrant cells of the myotome and sclerotome are responsible for the tumor growth and that the apparent mixed character is to be explained by the varying constituents which enter into the ultimate formation. (Wilms.)

(3) That these tumors are not due to inclusions from extrarenal sources, but are derived from the embryonic tissue of the true kidney, this tissue persisting and becoming metamorphosed into cellular structures of various types. (Busse, Muus, Ewing.)

A fourth theory advanced by Ribbert explains the tumor origin from a totipotent blastomere, misplaced at a state of development before the three primitive germ layers have been formed.

Gross Pathology.—The tumor masses in this series vary in weight from 100 grams to 1500 grams. They are usually round to oval in shape and are enclosed in a thick, grayish-white, connective-tissue capsule which is continuous with the external capsule of the remnant of kidney tissue. At one

FIG. 1.—Showing low-power view of embryoma of kidney. Note tumor mass separated by dense fibrous tissue from compressed kidney.

pole of the mass, often the lower, and extending slightly along one side of the mass, there is found a remnant of the original kidney, separated from the tumor by dense bands of connective tissue. The kidney tissue varies usually from a few millimetres to several centimetres in thickness and often a small amount of pelvis can still be recognized. The cortical striations stand out clearly and the cortex approximates its normal thickness. The tumor mass is usually irregular in external outline and the capsule is always tense and bulging. A few rounded nodules appear as elevated portions beneath the tumor capsule, distorting the shape of the mass. On section, the cut edges evert over the edge of the capsule. The cut surfaces of most of the tumors in this series show a striking similarity to one another. The tissue is firm, grayish-white to grayish-yellow in color, and is divided into two to four large lobules of irregular size by heavy strands of connective tissue, which can be clearly seen with the naked eye. Portions of the tumor show discol-

oration, hæmorrhage, and softening in scattered areas, varying from one to five centimetres in size. Occasionally, there is found one large lobule composed of numerous small, cystic cavities containing gelatinous material. The gross picture usually gives no indication of the particular microscopical variation of the tumor growth to be expected on histological examination. The tumor definitely arises within the kidney and shows its greatest effect upon the kidney by pressure atrophy. In one case, approximately two-thirds of the kidney remained and showed no gross or microscopical changes. It was separated from the large tumor mass above by a thick, connective-tissue capsule and such a clean plane of cleavage was present that the kidney could be separated from the tumor mass with little force, leaving behind an intact tumor capsule. More often, the normal kidney fuses gradually into the

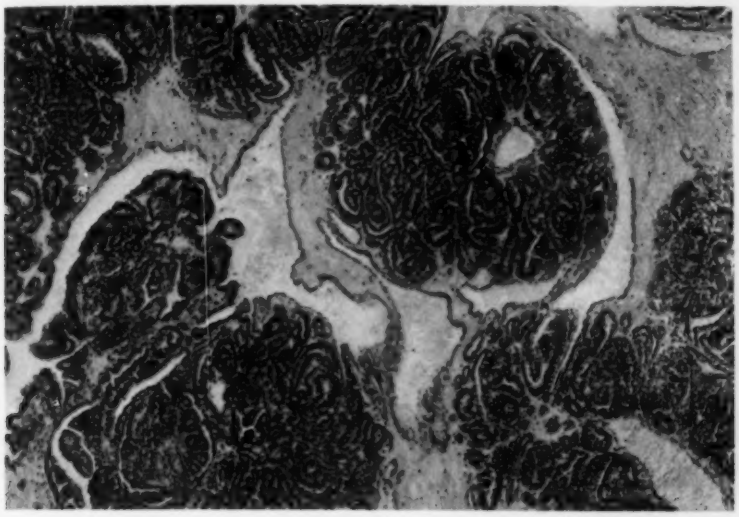

FIG. 2.—Low-power view showing glandular and papillary arrangement of tumor.

tumor. Definite boundaries can be found, however, on microscopical examination.

Microscopical Examination.—There is no one typical microscopical picture. Various types of cells in varying proportions, distribution, general arrangement, and degree of maturity are found. Two extreme pictures of the undifferentiated type are frequently noted. The first consists of large numbers of young, undifferentiated cells of the connective-tissue series which grow wildly and with no definite arrangement. The other shows a somewhat similar picture with young, undifferentiated cells of the epithelial series. In other portions of the same tumors, large areas can be found where cells of the epithelial type are arranged in tubule formation with lining cells, one to three cells deep. These tubules are often round and sometimes elongated or irregular in shape. Occasionally, abortive glomeruli can be found. The tubular structures are usually surrounded by loose, poorly arranged, connective-tissue stroma. Often papillary ingrowths are noted in these tubular structures, and occasionally in the same field, dense masses of similar cells growing in cords or clusters without lumina may be found. The typical cell in the tubules is hyperchromatic with a moderate amount of cytoplasm. A definite

cell outline is present, and the nucleus is usually elongated and vesicular in type with a rich chromatin network. In many of the tumors in this series, striated and smooth muscle cells could be found either rarely or in abundance, and on one occasion, a small amount of cartilage and bone was present. In two tumors, the predominating type cell was the striated muscle cell, although the other described elements were also present in small amounts. The marked variation in the microscopical picture is the most outstanding feature of this tumor. All variations from masses of undifferentiated, wildly growing cells with scant stroma to a fairly well differentiated structure containing abortive tubules and glomeruli can be found. In two cases studied at autopsy, metastases were found. One showed extension paravertebrally, and the other had metastases in the liver and lungs. The kidney remnants show essentially normal renal tissue except for the consequences of pressure of the tumor on the adjacent renal structures. No extension of the tumor into the kidney remnant proper is seen.

The numerous features of gross similarity of these tumors, regardless of their size or histological pictures, suggest that they belong to one homogeneous group of tumors arising within the kidney. No one explanation of the genesis of these tumors can be applied to all of them, and the final decision as to their genesis has not yet been made. To recognize these tumors as a definite group distinct from all other tumors in the general region of the kidney, and to apply the name "embryoma" to properly designate the known facts as to their genesis and microscopical and gross pictures, would seem the best way to leave this problem. The adoption of this designation, with a qualifying remark specifying the predominant cell type, appears to be the simplest and clearest means of classifying this type of tumor. The confusing nomenclature which has arisen in the literature adds nothing but perplexity to the understanding of this tumor. The designation *sarcoma* or *carcinoma* has no justification. A prognostic statement from a gross and microscopical study of an embryoma of the kidney must be made with great caution. The histological picture of the tumors removed from patients in this series still alive shows no striking differences from the tumors in the remainder of the group. Even when tumors are seen which show a considerable degree of differentiation, and appear to be comparatively slowly growing, the prognosis cannot be hopeful with certainty, for tumors of early life, in general, are notoriously malignant in their behavior.

Difficulty may sometimes arise in microscopically distinguishing the less differentiated type of embryoma from neuroblastoma arising from the adrenal medulla. Usually, however, the neuroblastoma has a distinctive picture characterized by the presence of the large, cylindrical and pyriform cells arranged about a central mass of granular material with "rosette" formation. The central granular material can be resolved into very delicate fibrils which can be traced into the pyriform cells. The most important element in the diagnosis of the neuroblastoma is this fibril, which is not to be confused with the coarser fibrils associated with connective-tissue and neuroglia cells. These fibrils are representative of axis cylinder processes.

Renal malignancies occur in childhood at any age and irrespective of sex. The vast majority are seen in the first five years of life and it has been

reported repeatedly in the fœtus. The youngest case in this series was five months and the oldest five and a half years. Either kidney is attacked with equal frequency and occasional bilateral instances have been reported, though the occurrence of bilateral tumors in the renal region is more commonly encountered in neuroblastoma of the adrenal.

Metastasis usually takes place by way of the blood-stream and implicates the lungs and the liver and rarely the opposite kidney or other organs. Dissemination occurs also by rupture of the tumor capsule and infiltration of the adjacent structures by tumor-cells. Secondary deposits are of the cellular type, the differentiated structures of the primary tumor being rarely found.

In childhood, symptoms of malignant disease of the kidney are generally absent. In contrast to the sequence of events in malignancy of the kidney

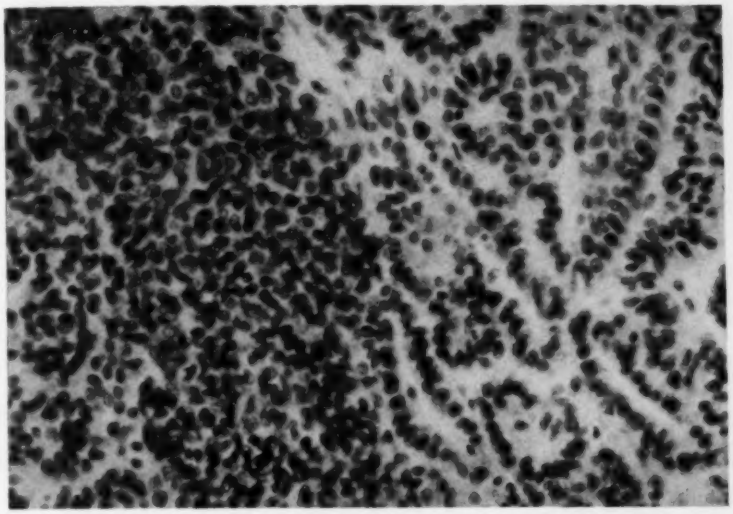

FIG. 3.—Low-power view showing abortive tubular structures and in the same field masses of tumor cells similar to those lining the tubular structures, growing in cords and clusters without lumina.

in the adult, where hæmaturia is often the initial symptom followed by pain and finally by tumor, the course of the disease in the child is silent, the danger signal of blood in the urine is practically never seen and the parents' concern is aroused at last only by the prominence of the infant's abdomen or the actual discovery of the mass. As the tumor progresses in size the child becomes irritable and evidences abdominal discomfort, but pain is rarely a salient feature. A secondary anæmia is usually present, constipation may develop from pressure of the mass and in the terminal stages there are dilatation of the superficial abdominal veins and rapid wasting. Nevertheless, it is remarkable in what good general condition a child may be with an enormous renal tumor.

It has been stated that trauma may be an etiological factor in renal neoplasms but no substantiation for such a statement can be found in our

series. In one instance, trauma initiated a severe attack of hæmaturia, but the growth was far advanced at the time of the injury.

The diagnosis is seldom in doubt as the progress of the growth is generally far advanced at the time of examination of the child. The tumor is usually solid, not tender, and smooth or somewhat nodular. Where marked irregularity of the tumor and fixation are present it is usually found that the neoplasm has broken through its capsule and enucleation is extremely difficult or impossible. At times the great proportions of the tumor render it immovable and yet the capsule is found to be intact and extension has not occurred. When rapidity of growth has caused central necrosis or there has been hæmorrhage into the tumor, a sense of fluctuation may be obtained.

As neoplasm enlarges it grows along the lines of least resistance; namely,

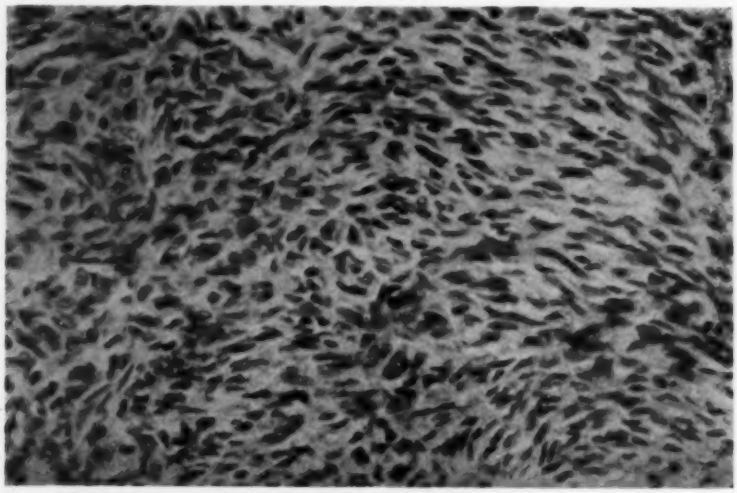

FIG. 4.

downward and anteriorly. At first the colon lies over its anterior surface and then gradually the peritoneal cavity with its contents is displaced toward the opposite kidney. The demonstration of mesial displacement of the colon by radiographical means is good evidence of the retroperitoneal character of the tumor.

In the differential diagnosis, other renal tumors, such as polycystic kidney, solitary cyst and hydronephrosis, should be borne in mind and splenic and hepatic enlargements excluded. The malignant tumor of the adrenal medulla is at times impossible of exclusion. Neuroblastoma of the adrenal occurs with less than one-fourth the frequency of embryoma and is generally characterized by the extensive metastases to the liver or to the flat bones of the skull, particularly of the orbit. Occasionally a case is encountered in which there is rapid local growth of the adrenal neoplasm with no gross evidence of metastasis and in which the silent clinical course and the position of the mass simulate the true kidney tumor.

Pyelography is usually not necessary to establish the diagnosis, though occasionally in the early stage of the disease it may clarify a confused clinical picture, as occurred in one case in this series. The renal function test is of great importance as demonstrating an adequately functioning kidney on the involved side. In the large renal tumors of childhood the growth of the tumor occurs at the expense of the renal tissue and all that remains is usually a thinned-out, often functionless, strip of kidney with a fibrous zone of greater or lesser extent in contact with the tumor capsule. This intermediate zone represents renal parenchyma that has undergone fibrous degeneration from pressure of the mass. Encroachment of the tumor may obliterate the cavity of the renal pelvis and obstruct the ureter. As the neoplasm in rare instances is bilateral or may be sharply limited to one pole of the kidney, the demonstration of an adequate functional test does not necessarily prove the presence of an uninvolved kidney on the opposite side. However, the severity of a cystoscopic procedure in the very young patient, particularly the male, is attended by a definite risk and is unnecessary if one contemplates a transperitoneal nephrectomy, at which time the presence and normalcy of the other kidney can be readily proved.

Before proceeding to operation, evidence of metastasis should be ruled out by careful palpation of the liver and opposite kidney, and by X-ray examination of the chest. The size of the mass should be no contra-indication to exploration as it frequently occurs that a good plane of cleavage may be encountered and nephrectomy accomplished in the largest tumors. An outstanding example was in Abbé's case of an eight-months-old infant in whom a seven-and-a-half-pound tumor was enucleated. The kidney was not removed. This case was reported alive and well by Wollstein thirty-four years after operation.

During the period under discussion our percentage of nephrectomies has increased and the mortality has diminished. This has been attained by improved pre-operative and post-operative care and refinements of operative technic, particularly along the lines of hæmostasis, gentleness of manipulation and conservation of body heat. Probably the one factor of major importance in widening the scope of nephrectomy, has been the liberal use of transfusion both before and after operation. At the present time I believe that practically all cases should be explored except those in which metastasis or intraperitoneal extension can be demonstrated.

In the consideration of operative measures, three avenues of approach present themselves—the loin, the anterior extraperitoneal and the transperitoneal procedures. The advantages of the latter route are so marked in my opinion that a short discussion of the subject may not be amiss. The loin approach is used largely in European clinics but gives an inadequate approach to these very large tumors. Furthermore, exploration of the liver and the remaining kidney is denied and chromocystoscopy if not pyelography is demanded as a preliminary measure. The anterior extraperitoneal incision along the outer border of the rectus permits a more extensive operative field.

The peritoneum may be opened, the abdomen explored and the peritoneal incision sutured before proceeding to the enucleation of the tumor. The only advantage of this procedure over the transperitoneal route is a theoretical one—a lessened likelihood of implantation or dissemination of the neoplasm. This theoretical objection to the transperitoneal route, I believe, is not a valid one, as in three of the four cases alive and well at the present time, more than three years after operation, I used the transperitoneal approach. Certainly the advantages are preponderant, for in addition to abdominal exploration and adequate exposure, limited intraperitoneal extensions can be excised with the tumor.

Regarding anæsthetic, we have found that avertin used as a basal anæsthetic, 80 milligrams to the kilo. body weight, with a supplementary light

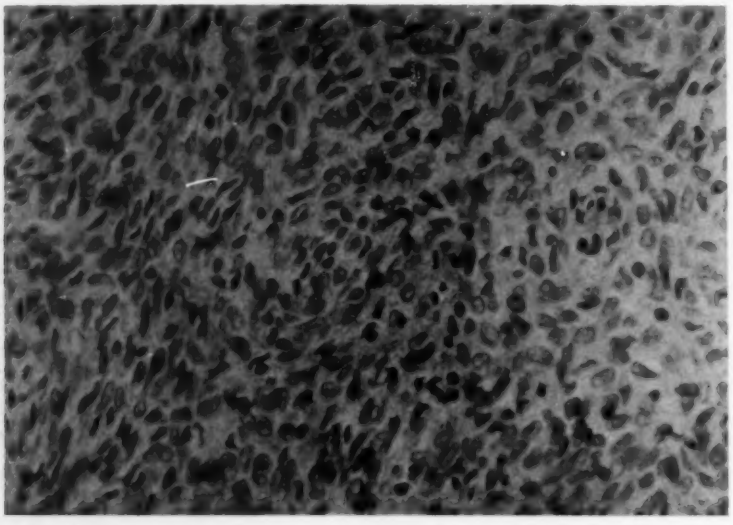

FIG. 5.

FIGS. 4 and 5.—Medium-power views showing more wildly growing, less differentiated tumor cells without any definite arrangement.

drop ether, is a most satisfactory method in this type of operation as in other procedures of magnitude on young children.

Robins, at the 1922 meeting of this society, reported his experience with four instances of renal neoplasm in childhood. One child, one year of age at the time of nephrectomy, was alive and well without evidence of recurrence twenty-two months after nephrectomy. The prognosis in a few recently reported series may be cited: Kretschmer and Hibbs, 1931, seventeen cases, a child of thirteen months well one and a half years after nephrectomy, for a mixed tumor. Hyman, 1930, seventeen cases, one boy of nine with hypernephroma, well ten years after nephrectomy. Wollstein, 1927, eighteen renal malignancies, two patients alive and well thirty-four years (Abbé's case) and six and three-quarters years respectively, after operation.

Local recurrence is prone to occur, a palpable mass being manifest within a few months and progressing with startling rapidity. One of the few

exceptions to the usual behavior of recurrences was reported by Franks, where death did not occur until ten years after operation. Walker has stated that the average duration of the disease without operation was eight months, while in nephrectomized cases it was 16.8 months. Our experience, on the contrary, has been that in our cases recurrence has been noted in from three to six months and death almost invariably ensues in less than one year.

TABLE I

Embryoma of Kidney

Number of cases	30
Sex: male, 16; female, 14	
Average age: two and one-half years	
Side: right, 16; left, 14; bilateral, 0	

Initial Symptom

Palpable tumor	17
Pain	8
Malaise and weakness	3
Hæmaturia	1
Digestive symptoms	1

Palpable mass in renal region present in every case.

TABLE II

Nephrectomized Cases without Evidence of Recurrence
Pathological Diagnosis—Embryomatous Mixed Tumor

	Age at Op.	*Sex*	*Side*	*Follow-up*	*Years since Op.*
(1)	11 mos.	Male	Left	By letter	12
(2)	2 7/12 yrs.	Female	Right	Examined	6 7/12
(3)	1 yr.	Female	Right	Examined	3 10/12
(4)	10 mos.	Male	Left	Examined	3 9/12
	Total number of nephrectomies				22
	Three-or-more-year cures				4—18.2%
(5)*	2 1/2 yrs.	Female	Left	Examined	2

* Has increasing paralysis of lower extremities. Question spinal-cord tumor or poliomyelitis. No local recurrence. Possibility of metastasis to spinal cord cannot be ruled out, though it is considered unlikely.

TABLE III

Embryoma of Kidney—30 Cases

Nephrectomy	22	Biopsy	6
Operability	73.3%	Operative deaths	2
Operative deaths	4—18.2%	No operation (autopsy reports)	2
Died from recurrence	11	Metastases: lungs	2
Alive with recurrence	1	Extension:	
No evident recurrence 3½ months	1	Adjacent lymph-nodes	4
Alive 2 years post-operative with possibly a metastasis to spinal cord	1	Peritoneum	4
		Intestine	1
No recurrence 3 years or more	4—18.2%	Renal vein	1

TABLE IV

Pathological Diagnosis Other Than Embryoma or Neuroblastoma

Number of cases: 7

Path. Diag.	*Sex*	*Age*	*Side*	*Operation*	*Course*	*Late Death*
(1) Malignant tumor of epithelial origin	Male	6⅓ mos.	Right	Nephrectomy		2 mos. post-operative
(2) Small round-cell sarcoma	Female	3 yrs.	Left	Nephrectomy	Post-operative death	
(3) Small spindle-cell sarcoma	Male	4 2/12 yrs.	Left	Nephrectomy	Recovery	Recurrence 2 mos.
(4) Invading granuloma (?)	Female	19 mos.	Left	Nephrectomy	Recovery	Not traced
(5) Hypernephroma	Male	4 2/12 yrs.	Right	Nephrectomy	Post-operative death	
(6) Sarcoma	Male	3 yrs.	Left	Biopsy	Recovery	Death 5½ wks. after onset
(7) Fibrorhabdomyosarcoma (kidney anlage)	Female	4 yrs.	Right	None		Death 4½ wks. after onset

No pathological report available. Number of cases, 4.

TABLE V

Statistics for Total Group of 41 Renal Tumors

Cases deemed inoperable without exploration	3 cases
Exploration	10 cases
Nephrectomy	28 cases
Operability (41 cases)	68.5%
Operative deaths	6 cases
Operative mortality	21.4%
Not traced, died or probably died from recurrence	15 cases
Living with recurrence eight months post-operative	1 case
Living without recurrence three and one-half months post-operative	1 case
Living with symptoms probably not due to recurrence	1 case
Alive and well three years or more after operation	4 cases
Two-year-or-more cures (4 or 5 cases)	9.8% or 12.2%

As a curative procedure, X-ray or radium radiation is of no avail. X-ray as a palliative measure is still used, though I feel that little benefit may be expected from its use.

From collected statistics the statement is made that the combined mortality from operation and late recurrence is between 86 per cent. and 93 per cent. The immediate operative mortality is from 24 per cent. to 40 per cent.

The statistical data derived from a study of this group of cases is given in the accompanying tables. The operative mortality for the whole group of nephrectomies was 21.4 per cent., while in the group classed pathologically as embryomatous mixed tumors it was 18.2 per cent. In the last eleven nephrectomies there has been but one operative death. The combined immediate and late mortality in the larger group was in the vicinity of 90 per cent. It is interesting to note that all surviving cases belong in the group of thirty definitely classified embryomas, there being four who have lived three years or longer without evidence of recurrence, a curative rate of 13.7 per cent. for

the group or 18.2 per cent. of the twenty-two nephrectomized patients. A point of possible significance in the analysis of these few three-year cures is that the average age at the time of operation was sixteen months, in contrast to the average age of the embryomatous group as a whole, which was thirty months. Another point of interest is that, whereas the tumor in three of the cases was of the usual large size, the fourth three-year cure occurred in the patient from whom the smallest embryoma of the series was extirpated. In general, I believe the outlook for patients who have survived a two-year period without recurrence is better than in other types of malignancy, as recurrence and death so rapidly follow nephrectomy in the vast majority of renal neoplasms of childhood.

Grateful acknowledgment is due Dr. Sidney Farber, pathologist of the Children's Hospital, for the concise description of the pathology and the statement of the opinion we hold regarding the origin and classification of the renal tumors of childhood.

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SARCOMA OF THE KIDNEY OF THE ADULT

A REVIEW OF TWENTY CASES WITH A REPORT OF A CASE *

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AND

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Since 1901 at The Mayo Clinic 570 operations (485 nephrectomies and 85 explorations) have been performed for malignant tumors of the kidney. In only twenty-eight cases was the tumor sarcoma. In 464 cases the diagnosis was of hypernephroma or carcinoma, in forty-three cases of epithelioma of the pelvis of the kidney, and in thirty-five cases of malignant tumor of the kidney; all the patients in the last group were children.

Of the entire series, only twenty tumors were proved microscopically to be sarcomas arising from the kidney. Retroperitoneal tumors which invaded the kidney or were closely associated with it were not included. Eight of the twenty cases were reported by Hunt and Hager,[1] in 1929. The history of a case observed recently will suffice to emphasize significant factors occurring in the course of the disease and its treatment.

A man, aged forty-six years, who came for consultation July 20, 1931, complained of pain in the upper left side of the abdomen of two months' duration. It was severe in onset and radiated to the left lumbar and left inguinal regions. The attack lasted about five days, and was followed by dull, constant pain, at times associated with nausea. He had not noticed hæmaturia and had not had any urinary symptoms.

The patient weighed 172 pounds. His weight had remained stationary. The systolic blood-pressure was 130 and the diastolic 90 in millimetres of mercury. A mass could be felt in the region of the left kidney. Urinalysis showed albumin graded II, a few granular casts, pus graded I, and no erythrocytes. The concentration of hæmoglobin was 93 per cent.; leucocytes numbered 8,300 in each cubic millimetre of blood. The Wassermann reaction of the blood was negative. A flat röntgenogram of the kidneys, ureters and bladder showed a large shadow in the region of the left kidney. Cystoscopical examination revealed a mass suggestive of a solitary cyst, although the presence of a neoplasm was considered probable. There was a marked ptosis of the right kidney, but this did not interfere with its function.

Left nephrectomy, performed July 27, 1931, revealed that a large tumor had almost destroyed the kidney (95 per cent.). The pathologists reported fibrosarcoma graded IV. It weighed 1,200 grams and measured fifteen by fourteen by thirteen centimetres. Giant cells were present. (Figs. 1, 2 and 3.)

Convalescence was uneventful and the patient was able to leave the hospital on the twenty-fifth day after operation. He was given a series of Röntgen-ray treatments before returning to his home. A letter received four months later stated that his health was good.

* Submitted for publication April 6, 1932.

The sarcomas of the kidney of adult patients were equally divided among the sexes; ten patients were men and ten were women. The youngest patient was aged sixteen years and the oldest was sixty-eight years; the average age was forty-three years. The most common symptoms were pain, hæmaturia and loss of weight. In only five cases were there any symptoms referable to the bladder. Seventeen of the patients complained of pain; eleven stated that it was severe. The majority of the patients had noticed pain for less than a year. Sixteen had lost weight; the average loss was twenty-four pounds. In seven cases only hæmaturia had been observed and in six of these it had been present for less than a year. A palpable tumor was demonstrable in eighteen cases at the time of our examination. Six of the patients had detected the tumor before coming to the clinic. Some albuminuria was

FIG. 1.—Fibrosarcoma which has almost destroyed the kidney.

present in fourteen cases, pyuria in thirteen, and microscopical hæmaturia in seven. The studies of the blood did not reveal anything of significance. The concentration of hæmoglobin was estimated and averaged 66 per cent.

A positive diagnosis of renal tumor was made by cystoscopical examination in fifteen of the twenty cases. In one case the diagnosis was pyonephrosis. In another it was pyonephritis, which was thought to be sufficient to require surgical interference. In two of the cases cystoscopical examination was not done. In one case cystoscopical examination was carried out but failed to reveal the true condition.

Nephrectomy was performed in nineteen of these cases. In one case exploratory operation and biopsy were carried out. In eight of the twenty cases Röntgen-ray treatment was given post-operatively. The left kidney was the site of the lesion in eleven cases and the right kidney in nine.

Six of the tumors in the series were fibrosarcomas. Six were diagnosed as sarcoma and the character was not specified. One tumor was a round-celled sarcoma, one a mixed-celled sarcoma, one a myxosarcoma, one a fibro-myxosarcoma, one a liposarcoma, and three were spindle-celled sarcomas. One of the specimens contained fibrosarcoma, graded III, associated with adeno-carcinoma graded II in the same kidney. The specimen weighed 1,675 grams. Most of the twenty tumors were large; one weighed 2,700 grams. The average recorded weight was 1,262 grams and the average size was fifteen by fourteen by twelve centimetres. In only two cases was there any suggestion that the tumor might have arisen from the capsule of the kidney; the remainder apparently arose from the connective-tissue framework of the substance of the kidney.

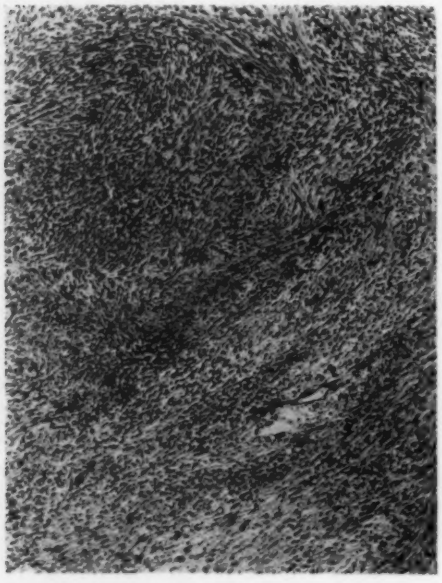

FIG. 2.—Character of fibrosarcoma is shown.

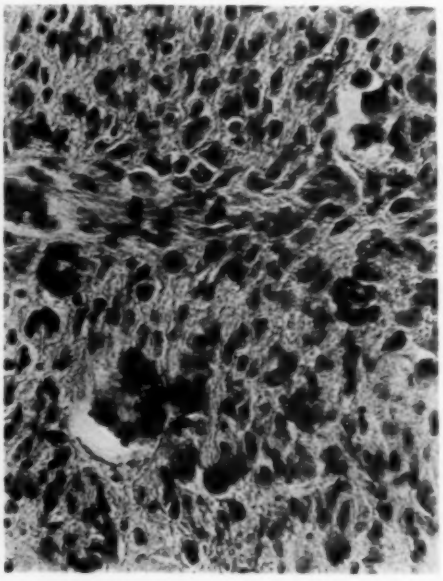

FIG. 3.—Character of cells, tumor giant cells and mitotic figures are shown.

The prognosis, in cases of sarcoma of the kidney, is very poor. Three of this series of patients died shortly after the operation. Most of the deaths occurred within the first year after operation. One patient lived eight years and then died, supposedly from pulmonary tuberculosis. Another patient was reported to have died from pneumonia one year after operation. One is living six years and three months after nephrectomy for fibrosarcoma graded II. In this case the surgeon recorded the fact that it was impossible to remove all of the malignant tissue. A series of Röntgen-ray treatments was given post-operatively. Recently the patient stated that he has gained thirty-five pounds. However, he reported the presence of a lump in the operative site, but it is not increasing in size. One patient is living two years and three months after nephrectomy and one is living four months.

SUMMARY

Sarcoma of the kidney of the adult is comparatively rare; only twenty cases were observed in thirty years at the clinic. Apparently, the majority of these tumors arise from the supporting tissue of the substance of the kidney rather than from the capsule. Usually, the tumor is large and it can be palpated. Fibrosarcoma is the type most frequently seen. In our series, pain and loss of weight were the prominent symptoms. The ultimate prognosis in cases of sarcoma of the kidney is poor: only two patients of our group lived more than three years; most of them died within a year of the time they came for treatment. Nephrectomy followed by Röntgen-ray treatment seems to be the procedure of choice.

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STANNOXYL IN THE TREATMENT OF CHRONIC RECURRING OSTEOMYELITIS

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One of the most annoying and unsatisfactory conditions for the physician to treat is the residual chronic suppuration, associated with sequestrum and sinus formation, which are the usual sequelæ after an attack of acute osteomyelitis. These patients cannot be weaned from the hospital and dispensary and come back repeatedly for reoperations. At best the majority lead a life of semi-invalidism. If they have a persistent discharge from sinuses there is usually a marked secondary anæmia and not infrequently amyloidosis. At present the surgical methods leave much to be desired. The radical chiseling and gouging of the affected bones and widespread exposure of the affected areas do not permanently cure these cases. The maggot treatment which is becoming popular is intricate and involves more surgery. Under these conditions it should be highly desirable to have some chemo-therapeutic agent which may be taken orally and which is deposited in the reticulo-endothelium of the bone-marrow, where it might exert a bactericidal action. In this connection it is of practical interest to refer to the report of R. Gregoire and A. Frouin,[1] who, in 1917, carried out some valuable studies on the effect of tin-oxide and metallic tin on staphylococcic infections. They found that in the French province of Beauce the tin miners never suffer from furuncles, and that powdered tin is a popular remedy against this type of infection. These authors have studied the action of tin on the staphylococcus and on animals. They have shown that tin and its oxide are absorbed by the digestive tract, that it is quite harmless to the organism, and also that it has a therapeutic action in staphylococcic septicæmias. They successfully treated two cases of furunculosis, one case of chronic osteomyelitis, and one of compound fracture of the femur associated with suppuration by the administration of a mixture of tin-oxide and metallic tin (stannoxyl).

In a small series of five cases under my personal care the results have been so notable that I feel it desirable to report briefly the benefits which followed the oral administration of tin preparations in individuals suffering from chronic osteomyelitis.

Case I.—F. K., at the age of twelve years, June 20, 1923, was admitted to the Michael Reese Hospital with symptoms of acute osteomyelitis in the left tibia. The tibia was opened and drainage established. The impression of the surgeon at the time was that the osteomyelitis was due to streptococcal infection of hematogenous origin. His condition was very serious and necessitated hospitalization for one year due to com-

[1] Gregoire, R., and Frouin, A.: Action de L'Oxyde D'Etain et de L'Etain Metallique. Bull. Acad. de. Med. Par., vol. lxxvii, p. 704, May 29, 1917.

plications and reoperations. Since his discharge from the hospital in July, 1924, the patient has had acute exacerbations at times, which have necessitated re-hospitalization and reoperation, including seven sequestrectomies.

June 18, 1930, he again developed an area of acute inflammation in the upper third of the left tibia, a type of reaction which had previously required reoperation. He was given stannoxyl, two tablets four times daily by mouth. Within five days the inflammation had completely subsided. The patient has been completely well since then, is in good general condition and is well enough to participate in athletics.

CASE II.—S. S., admitted to Michael Reese Hospital in June, 1926, at the age of twelve years, with an acute osteomyelitis of the right femur. At operation drainage was instituted by wide exposure of the femur on its lateral aspect. After several months in the hospital he was discharged. December 6, 1928, he was readmitted with a recurrence in the same bone associated with fever, (102). At this time by operation the upper and lower sinuses were connected by making an extensive gutter in the

FIG. 1.

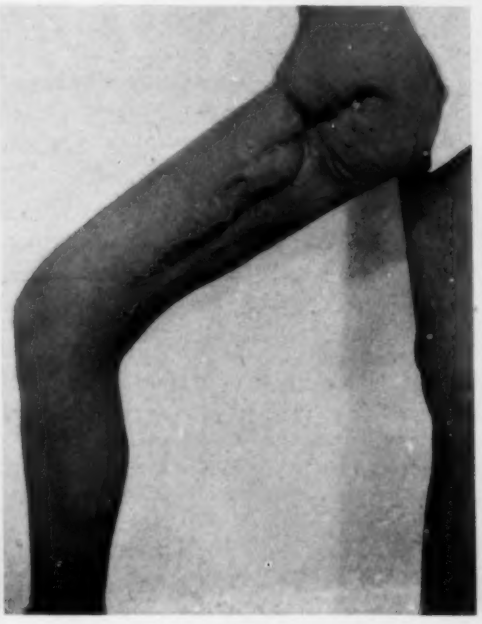

FIG. 2.

FIG. 1.—S. S., healed scar after stannoxyl treatment of osteomyelitis.
FIG. 2.—A. W., healed scar after treatment of chronic osteomyelitis with stannoxyl.

intervening femur. He was discharged March 26, 1929, with drainage still persisting from the wound. He was readmitted December 19, 1929, with another exacerbation. A sequestrectomy was performed. He was discharged January 9, 1930. Since then the patient has been visiting the dispensary where La Porte dressings have been applied. There has been a persistent discharge from one sinus for the past two years. The patient's condition was poor at this time, showing signs of secondary anæmia and a marked acne on the face.

February 7, 1932, the local applications were discontinued and oral treatment with stannoxyl was started. The dosage was two tablets every four hours. February 17 the patient stated that there was less discharge from the sinus and that he felt better. His weight at this time was 135 pounds. February 25 he reported a progressive diminution in the amount of discharge. March 2 the discharge had become sero-sanguinous; weight was 136 pounds. March 9—wound practically healed; slight scab over sinus;

weight 137 pounds. The facial acne has completely disappeared. April 7 weight 137½ pounds; no discharge; wound healed. (Fig. I.) The patient volunteered the information that he felt better than at any time in his life; that he does not get tired as formerly.

CASE III.—A. W., male, aged nineteen years, was admitted to Michael Reese Hospital at the age of seven years with an acute osteomyelitis of the left femur. Up to February 24, 1931, he had been subjected to eight sequestrectomies. He was discharged with this note: That the osteomyelitis was still present and that he probably had amyloidosis. When I examined him February 10, 1932, he had five sinuses on the left thigh. There was an extensive operative scar over the lateral aspect of his left thigh and over the left hip. There was one large discharging sinus about four inches in extent at the lower end of the scar. There were three smaller discharging sinuses about the hip and one small sinus on the internal aspect of the thigh near the groin. The left thigh presented a flexion and abduction deformity at the hip of about 45°. The dressings showed a profuse, thick, greenish-yellow discharge.

February 10, 1932, he was given stannoxyl, two tablets every four hours. February 17 the wound looked better, although there was still the same amount of discharge. February 25, weight 140 pounds; less discharge. March 2 wound was much smaller; the three small sinuses about the hip were closed; weight 140½ pounds. March 9 large sinus down to one inch in width; weight 141½ pounds, feels better. March 23 discharge has sanguinous nature; wound smaller. March 30 wound smaller; still some discharge; weight 143 pounds. April 7 wound rapidly healing; weight 144 pounds. (Fig. 2.)

In the previous two cases it was noted that there was a marked improvement in the general condition as shown by the rapid gain in weight. In the former case a beneficial effect was also noted on the facial acne. There was a marked healing effect observed on the sinuses. When the healing process is advanced the drainage from the sinus assumes a sanguinous appearance.

CASE IV.—J. O., female, ten years old, was seen in consultation with Dr. J. Seilin, through whose courtesy this case record is presented. The patient had an acute osteomyelitis of the left femur. November 15, 1930, she was operated on and a typical osteomyelitis was found in the lower third of the femur, with stripping of the periosteum from the posterior surface of the femur at the linea aspera. She was discharged April 5, 1931, with some purulent drainage still present from the operation wound. May 5, 1931, X-ray examination showed the presence of three small residual bone abscesses in the lower end of the left femur. By May 10, 1931, the wound had closed completely. A tonsillectomy was done May 27, 1931. September 23, 1931, there was recurrence; the thigh sinus reopened; X-ray revealed a small cortical and pereosteal abscess of the femur. At this time the patient was placed on the stannoxyl treatment, eight tablets daily. The sinus was completely closed by October 5, 1931, and there have been no recurrences since.

CASE V.—Mrs. P. M., aged sixty years, is reported through the courtesy of Dr. G. G. Herpe. She was seen February 1, 1931, when she was suffering from an arteriosclerotic gangrene of the fourth toe on the left foot. After attempts at local treatment it was found necessary to amputate the toe. The wound remained open and drained constantly, the adjacent part of the metatarsal bone having become necrotic. A sequestrum formed and a sinus developed with an opening on the sole of the foot. The sequestrum was removed, but the sinus continued draining. In March stannoxyl tablets were given, six daily. Within four weeks the discharge had ceased and the sinus had closed.

In this brief series there has been no doubt as to the marked therapeutic effect of tin and tin-oxide in chronic suppuration involving bone tissues.

To determine whether tin exerts a direct bactericidal effect on staphylococci

I added tin-oxide and tin to several Petri dishes of agar. These plates were inoculated with *Staphylococcus aureus*; the staphylococci grew luxuriantly on this medium and showed no difference in amount or quality of growth from the control plates. Probably it exerts its therapeutic action through the reticulo-endothelial system, as is apparently the case with some other metallic drugs of great therapeutic value such as salvarsan and bismuth.

CONCLUSIONS

(1) Treatment of five cases indicates that tin-oxide and metallic tin exert a marked curative effect on chronic osteomyelitis with persistent sinuses and suppuration.

(2) The treatment is conservative, harmless and apparently effective.

(3) The effects in the limited number of cases reported are so positive that wider and more tests should be made and the results recorded.

NOTE.—Stannoxyl comes in 3 grain tablets of the following composition: metallic tin—42.5%; tin oxide—7.5%; amylum 37.5%; sucrose—12.5%.

POST-PYLORIC ULCER UNDER THE THERAPEUTIC MANAGEMENT OF INTERNIST, RADIOLOGIST AND SURGEON *

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from the surgical service of the fifth avenue hospital

The combined efforts of the internist and surgeon have greatly reduced the morbidity and mortality in diabetes and toxic goitre. In contradistinction to this policy, it may be stated that in lesions of the duodenum the internist and surgeon have in general directed their energies in attempts to prove which could muster sufficient statistics to damn the end-results of the other.

Four years ago, at the beginning of my connection with the Fifth Avenue Hospital, Doctor Tenney, chief of the medical service, Doctor Cole, of radiology, and the surgical department decided we would attempt to see whether our combined efforts would improve the therapeutics of duodenal ulcer. It was decided that there should be no operation upon the ulcer unless two out of the three voted in favor of this procedure. The general precepts established in favor of operation were: first, failure of cure after adequate medical therapy; or, second, radiological evidence of the likelihood of perforation. In addition, the surgical department agreed that it would remove any possible foci of infection if this were recommended by the internist and radiologist. This in general means that tonsils, teeth or appendices would be removed without operative interference upon the ulcer. The medical department agreed that it would work in harmony with the surgical department—not only in the pre-operative preparation of the patient but also in the post-operative and post-hospital management. The radiological department, under the stimulus of Doctor Cole and Doctor Pound, has made a thorough study of the anatomy, physiology and motor phenomena of the gastro-intestinal tract in association with the patient's clinical manifestations. Therefore the advice and coöperation of this department are great aids in the general problem of therapy. While the question may be raised whether or not the radiologist should do more than describe the actual defects seen, it may be definitely stated that in our individual situation the therapeutic advice of the radiological department has been of great value. When an operation has been performed, the radiologist has attended the operation, scrubbed up, so that he could inspect the lesion and palpate it, and if a specimen were removed he has taken the specimen and by immediate injection maintained the contour as seen in the living body. He has studied the gross pathology of these lesions, as well as the microscopical. This department has also been very generous in the taking of follow-up films and in the duodenal operative series has

* Read before the New York Surgical Society, March 9, 1932.

personally seen the return post-operative cases in follow-up and has attempted to estimate from an impartial point of view the clinical results. In a combination where the surgeon and internist may take opposite views relative to therapy to be adopted the radiologist has often the deciding vote. He has the advantage of having seen the results of numerous methods of treatment in the hands of a wide number of physicians and surgeons, and he is an impartial observer in that he is not under obligation to either medical or surgical therapy.

As this report deals with the surgical phases of duodenal ulcer, no attempt has been made to evaluate the results of the purely medical therapy. This article deals mainly with: (*a*) The follow-up results in cases where the appendix has been removed in patients suffering from symptoms suggestive of post-pyloric ulcer, with radiological evidence of pylorospasm or ulcer associated with radiological evidence of pathology of the appendix or cæcum; (*b*) the analysis of the mortality and end-results of operation upon the stomach or duodenum for post-pyloric ulcer. The material for this analysis is taken from: (1) The cases referred to the surgical division by the medical department for appendectomy. (2) The post-pyloric cases upon which operation has been performed by the senior author. This latter plan has been adopted because a more careful analysis can be made of the pre-operative indications and the follow-up.

In cases of pylorospasm or duodenal ulcer the indications of radiological evidence of pathology of the appendix have been based on the following evidence: first, deformity of the cæcum; second, retention of barium for more than 120 hours in a fixed appendix; third, a local point of tenderness over the appendix when manipulated under fluoroscopical control; fourth, fixation or angulation of the appendix; fifth, fecoliths remaining coated with barium for over five days; sixth, non-filling of the appendix by both barium enema and meal by mouth is suggestive but not conclusive, as the appendix may have filled and emptied between the periods of examination, and here clinical evidence of localized tenderness must also be considered in making the diagnosis.

The surgical department has removed the appendix in twenty cases of pylorospasm and thirteen cases of ulcer, when requested by the medical department. Frequently operations have been performed on radiological evidence solely, where there was no subjective or objective signs of appendicitis. As the operative procedure has been the same in these two types, they will be discussed as a common entity except in their follow-up analysis. Usually the surgeon has told the patients in cases of ulcer that removal of the appendix was an attempt to remove the focus of infection or source of irritation and might be merely a first-stage procedure, and that later, if improvement were not sufficient, an operation on the ulcer might be advised. The incision used has been either the McBurney or the right rectus—and the Kammerer modification of the right rectus is preferred to the rectus-splitting, in that it gives better exposure of the intercostal nerves supplying the rectus muscle. In general, an attempt has been made to retract the nerves and not cut them.

It has been felt that as small an incision as is compatible with the exposure of the cæcum and terminal ileum is the procedure to be adopted. No attempt has been made to explore the region of the duodenum. It has been felt that palpation will miss an ulcer in a large percentage of cases and that visual exposure is necessary to be certain of a diagnosis. Visual inspection would necessitate a large incision, which would delay the convalescence of the patient and possibly interfere with a subsequent operative procedure. Pericæcal bands have been freed where they have been thought of sufficient moment to create symptoms, and in three cases where there has been marked fixation of the terminal ileum a free omental graft has been used for peritonealization. Follow-up on these three cases has been excellent. The appendix has been removed with a double inversion of the stump, and careful peritonealization. There has been no operative mortality.

Follow-up.—The analysis of the cases wherein the appendix has been removed has been classified as follows: (1) Good, where the patient may eat any type of food without any epigastric distress. (2) Fair, where the patient suffers occasional distress from dietary indiscretions. (3) Poor, where apparently the removal of the appendix has had no influence on the therapeutic treatment of the ulcer or pylorospasm. It may be stated that in the classification of the end-results it is difficult to evaluate an appendectomy. It is well known that there are long periods of remission in ulcer and also that many ulcers are cured by purely dietary measures. Recognizing these facts, we have tried, so far as possible, to classify the results as fairly as we can.

These cases have been followed for at least one year to rule out the possibility of early recurrence.

Appendectomy for Ulcer or Pylorospasm.—There have been eleven cases of ulcer for which appendectomy alone was done. Of these, two are lost in the follow-up. Of the others, five are good, two fair and two poor. Of the good cases all had definite pathology in the appendix as evidenced by kinks, adhesions and fecoliths; and all had extensive adhesions around cæcum and terminal ileum. Of the fair results both had kinked adherent appendices but there was little or no involvement of the cæcum and ileum. Of the poor results one had fecoliths in the appendix and the other had little or no abnormality. In the two lost cases the appendix did not show any abnormality at operation. If any deduction can be drawn from this small number of cases it might be said that the benefit of the operation is in direct proportion to the amount of abnormality in the appendix, cæcum, and terminal ileum.

There were two cases in which the X-ray or the operative findings indicated a healed ulcer. The results were good in both cases and in both cases adhesions between pylorus and gall-bladder had to be freed. In one there were also pericæcal adhesions and in the other there were adhesions binding the appendix.

There were twenty cases of pylorospasm as shown by X-ray. The results were: Good, eleven; fair, five; poor, none; not followed, four. Five of these had adhesions of terminal ileum and cæcum in addition to abnormality in

the appendix and the result was good in four and fair in one. All the others had some abnormality but limited to the appendix. The appendix is considered to be normal when it shows adhesions, kinks either from adhesions or short mesenteriolum, constrictions, or fecoliths. Little importance is attached to simple obliteration without some of the other abnormal features mentioned. Two cases in this group also had cholecystectomy performed. One case is lost and the other is rated as good.

	Total	Good	Fair	Poor	Not followed
Ulcers	11	5	2	2	2
Healed ulcers	2	2			
Pyloroplasm	20	11	5	0	4
Excluding lost cases					
Ulcers		64%	18%	18%	
Pyloroplasm		69%	31%		

Operations for Duodenal Ulcers.—With a system such as has been adopted at the Fifth Avenue Hospital, it is obvious that the number of cases coming to the surgeon will be relatively small. On the other hand, this series comprises cases that have had a long course of medical treatment and are medical failures. Follow-ups on these cases should not be compared with a medical series, which may include duodenitis, superficial ulcers and early penetrating ulcers.

In all, twenty-five consecutive cases are included in this report. Two of these patients had had a previous suture of a perforated ulcer, one case a previous cholecystostomy and one a previous cholecystectomy. There was no immediate operative mortality in this series. One death a year and a half post-operative is reported in the follow-up analysis.

Types of operations performed were: Gastroenterostomy, one case for healed ulcer, with marked pyloric obstruction. Judd pyloroplasty, three cases. Subtotal gastrectomy with a retrocolic Polya anastomosis, two cases. Subtotal gastrectomy with a Finney modification of Billroth II end-to-side gastroduodenostomy, two cases. Modified Devine operation of antral exclusion with Polya retrocolic gastrojejunostomy, seventeen cases.

The type of operation has been planned from the pre-operative study of the X-ray plates, the patient's symptoms, and the findings at operation. Where ulcer has appeared to be large and the deformity marked but where there has been what appeared to be a mobile duodenum resection has been done with the Finney modification of Billroth II. Where the evidence beforehand suggested that there was a small ulcer on the anterior surface, a Judd pyloroplasty has seemed to be the operation of choice. Gastroenterostomy has been used only once in this series. The majority of cases treated have been chronic, without retention, recurring after medical treatment, and therefore it was considered advisable to either resect the ulcer or exclude it from the food current. By far the greater number of cases have been operated on by the modification of the Devine method of pyloric exclusion. This

operation has seemed to combine the good points of the resection with a marked lessening of the operative risk. As the operation has been thoroughly described elsewhere, only a brief description will be given here.* The stomach is transsected just proximal to the re-entrant angle. The mucous membrane is coned out of the antrum down to the pylorus and removed. The mucous membrane at the pylorus is inverted and sutured and the antrum is closed with several purse-string sutures. A retrocolic gastrojejunostomy of the Polya type is then performed with a very short jejunal loop. Anastomosis is so arranged that the proximal portion of the jejunum is sutured to the transsection of the stomach beginning at the lesser curvature. The advantages of this procedure are that it leaves a very satisfactory closure of the pylorus, the ulcer is placed in an alkaline field at rest, there is not the danger of attempting excision of an ulcer adherent to the pancreas, and it is unnecessary to ligate the vessels of the lesser and greater curvatures save at the areas of transsection.

In the cases operated on by the Devine method, there have been two post-operative complications of considerable moment, which were not attributable to the operation *per se*. One patient had a very stormy convalescence and was readmitted to the hospital a year and a half later with an upper jejunal obstruction. Jejunostomy was performed. She apparently recovered and returned home, but was readmitted about three weeks later with another intestinal obstruction. A lateral enteroenterostomy was performed, but she died of obstruction and peritonitis. Post-mortem examination revealed a hernia of the proximal loop of the jejunum just distal to the stoma into the lesser peritoneal sac through the gastrocolic omentum posterior to the anastomosis. In reviewing the history and post-operative follow-up films it seems evident that this herniation had occurred immediately post-operative. In this particular case the transverse mesocolon had been sutured to the anterior surface of the stomach but not to the posterior. It is needless to say that since that time care has been taken in suturing the mesocolon not only to the anterior but to the posterior surface of the stomach proximal to the stoma.

The second patient had gall-stones, as well as duodenal ulcer, and a simultaneous cholecystectomy was performed. He developed post-operatively a biliary fistula, ran a stormy post-operative course and subsequently a common-duct drainage was performed with a T-tube. He is still wearing the tube, is gaining weight and has no gastric disturbance, but there is still some evidence of common-duct obstruction.†

It is felt that the absence of mortality in twenty-five consecutive cases of operation for post-pyloric ulcer is attributable to careful pre-operative preparation, meticulous post-operative care and very close coöperation of the

* A modification of the Devine operation of pyloric exclusion for duodenal ulcer: American Journal of Surgery, May, 1932.

† Since the submission of this article the T tube has been removed, the patient has gained 25 pounds in weight, has no gastric disturbance and feels well.

CASE NUMBER	55181	54345	53467	51817	51659	51237	51191	50789	49829	45435	44134	41545	39919	36533	36106	33841	31269
DURATION OF SYMPTOMS	6 YRS	8 YRS	1 YR	8 YRS	4 YRS	8 YRS.	4 YRS	4 YRS	4 MO	7 YRS.	7 MO	5 YRS	1 YR	2 YRS	3 YRS	5 YRS	7 YRS.
DURATION OF MEDICAL TREATMENT	5 YRS. PREVIOUS OP FOR PERFORATION	3 YRS.	9 DAYS	5 MO.	NONE	SPORADIC	NONE	1½ YRS.	4 MO	3 YRS	NONE	5 YRS	NONE	2 YRS. SPORADIC	NONE PREVIOUS OP FOR PERFORATION	5 YRS SPORADIC	NONE
DENTAL TREATMENT	PROPH.	EXTRACTION	PROPH. AND EXTRACTION	PROPH	PROPH.	TEETH O.K	TEETH O.K.	TEETH O.K.	PROPH	EXTRACTION AND PROPH	PROPH.	TEETH O.K.	TEETH O.K	TEETH O.K	PROPH	NONE	NONE
LENGTH OF PRE-OP TREATMENT	1 WK.	2 WKS	5 WKS	½ DAY	1 WK	1½ DAYS	2 DAYS	5 DAYS	2 DAYS	4 DAYS	3 DAYS	2 DAYS	3 DAYS	3 DAYS	5 DAYS	9 DAYS	5 DAYS
PRE-OP DIET	SMITHIES	FLUID	SMITHIES	NONE	SMITHIES	SMITHIES	BLAND	SMITHIES	SMITHIES	GRUEL	HIGH CALORIE	SOFT		SMITHIES	REGULAR	SIPPY	SMITHIES
ANESTHETIC	AVERTIN AND ETHYLENE	AVERTIN AND ETHYLENE	AVERTIN AND ETHYLENE	ETHYLENE	ETHYLENE	N_2O AND ETHER	ETHYLENE	ETHYLENE	AVERTIN AND ETHYLENE	ETHYLENE	ETHYLENE	ETHYLENE	ETHYLENE AND ETHER	ETHYLENE AND ETHER	ETHYLENE	ETHYLENE	ETHYLENE
ASSOCIATED OPERATION	VENTRAL HERNIA AND APPENDIX	MECKEL'S DIVERTICULUM APPENDIX	GALL BLADDER	NONE	APPENDIX	GALL BLADDER	APPENDIX	NONE	APPENDIX	APPENDIX	APPENDIX	APPENDIX AND GALL BLADDER	APPENDIX	NONE	NONE	NONE	NONE
HYPODERMOCLYSIS	5	7	6-3	4	4	2	5	2	4	3	1	3-2	3	1	2	4	3
WOUND INFECTION	NONE	NONE	YES	HEMATOMA	NONE	NONE	NONE	NONE	APPENDIX WOUND	NONE	NONE	NONE	NONE	NONE	YES	NONE	NONE
COMPLICATIONS	NONE	NONE	PNEUMONIA, BILIARY FISTULA COMMON DUCT OBSTRUCTION	NONE	NONE	NONE	NONE	NONE	NONE	NONE	PNEUMONIA	INTESTINAL OBSTRUCTION JEJUNOSTOMY	NONE	NONE	NONE	NONE	BRONCHITIS
OUT OF BED (P.O. DAY)	12	13	1st OP 33 2nd OP 20	16	12	12	11	12	14	12	13	20	12	14	20	15	16
DISCHARGED (P.O. DAY)	17	20	104	20	16	14	13	15	17	15	16	23	15	19	22	18	19
IMMEDIATE RESULT	GOOD	GOOD	GOOD FOR ULCER FAIR FOR GALL BLAD AND COMMON DUCT	GOOD	GOOD	GOOD	GOOD	GOOD	GOOD	GOOD	GOOD	FAIR	GOOD	GOOD	GOOD	GOOD	GOOD
LATE RESULT		GOOD 11 MO	GOOD FOR ULCER FAIR FOR COMMON DUCT 4 MO	GOOD 8 MO.	GOOD 8 MO.	GOOD 6 MO	GOOD 10 MO	GOOD 6 MO	GOOD 1 YR	GOOD 1 YR	GOOD 2 YR	DIED 2 YR INTESTINAL OBSTRUCTION	FAIR 2 YRS 50 % RELIEVED	GOOD 3 YRS.	GOOD 3 MO LOST	GOOD 3 YRS	GOOD 4 YRS VENTRAL HERNIA

CHART I

medical department with the surgical department in the post-operative management. We believe that the Levin tube, inserted through the nares immediately post-operative, with instructions that the stomach shall be washed every two hours, is a life-saving measure. By this means old blood clot is removed, and gas distention and vomiting post-operatively are prevented.

Charts I and II show the details of pre-operative and post-operative treatment.

The medical department have made rounds on the post-operative patients daily, as they would on medical cases, and in several instances have instituted post-operative therapy, which has seemed to prevent mortality.

Follow-up.—In analyzing the follow-up results, the patient has been

	Pre-op.	Day of op.	1st day post-op.	2nd day post-op.	3rd day post-op.
FLUIDS BY MOUTH	Forced	None	Aq. 1 oz. q. ½ h.	Aq. 1 oz. pep.mk. 1 oz. alternating q. 2 h.	Aq. 2 oz. pep.mk. 2 oz. alternating q. 2 h.
FLUIDS BY RECTUM	None	3 oz. q. 3 h.	3 oz. q. 3 h.	3 oz. q. 3 h.	3 oz. q. 3 h.
HYPODERMOCLYSIS	Once	Once	Twice	None	None
LAVAGE	Twice	q. 2 h.	q. 2 h.	None	None
ENEMAS AND COLON IRRIGATIONS	Enema twice	None	Colonic	Colonic	Colonic

CHART II

asked how soon he was able to return to his normal occupation, what dietary measures he is following, his personal habits relative to cigarette smoking and the use of tobacco, gain or loss of weight, and, finally, whether or not he would recommend this operative procedure to his closest friend or relative should he be suffering from a similar disease.

The gastroenterostomy case was followed for six months and then lost track of. At the end of six months his condition was excellent.

Of the three Judd cases two are excellent and one is poor, in that the patient still has symptoms of indigestion and pain if diet is not carefully followed.

In the four subtotal gastrectomies, one patient has been lost track of after three months, at which time he was well. The other three are classed as excellent.

Of the seventeen modified Devine operations two have not gone a sufficient time to judge sufficiently of the follow-up, though well when last seen.

One died at the end of a year and a half from intestinal obstruction. One is free from any gastric disturbance but is still wearing a T-tube in his common duct. Of the remaining thirteen cases, eleven are on non-restricted diets and feel well, while two have some gas or indigestion if they are careless of their diet. All thirteen, when questioned, said they would recommend the operation to their nearest friends or would have it done over again under similar circumstances.

CONCLUSIONS

First, we believe that a close therapeutic agreement between the radiological, medical and surgical departments has been of benefit to the patient suffering from post-pyloric ulcer.

Second, where an appendectomy for pylorospasm has been performed upon the recommendation of the medical and radiological departments, results have been satisfactory.

Third, where appendectomy has been performed for the removal of a focus of infection or a source of irritability, upon the recommendation of the medical and radiological departments, there has been an 82 per cent. benefit and an 18 per cent. failure in the cases analyzed.

Fourth, we believe that the mortality and morbidity of the patients operated upon for post-pyloric ulcer have been definitely reduced by the coöperation of the above-named departments.

THE LENGTH AND POSITION OF THE VERMIFORM APPENDIX*

A STUDY OF 4,680 SPECIMENS

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THE length of the appendix as noted in the literature from 1861 to the present time is given in Table I. Byron Robinson,[26] in 1895, stated that the appendix of the male is, on an average, 0.6 centimetre longer than that of the female. Fawcett and Blachford,[7] in 1900, studied 350 anatomic dissections and concluded that the appendix of the male is, on an average, 1 centimetre longer than that of the female; this was substantiated by Nowicki,[21] in 1909. Dock,[6] in 1892, stated that in his experience appendixes

TABLE I

Length of the Appendix as Given by Various Authors

Year	Author	Shortest, Centimetres	Longest, Centimetres	Average Length, Centimetres	Average Diameter, Centimetres
1861	Luschka		23.0		
1888	Ranschoff		19.0		
1890	Grauer (Kelly and Hurdon)		33.0		
1891	Ferguson	2.2		10.13	0.8
1892	Clado			8.0	
1893	Ribbert			8.3	
1893	Lafforgue		24.0		
1893	Bryant	0.6		8.25 at age of 60	
1895	Berry	3.1	13.3	8.3	0.6 at base 0.5 at tip
1900	Fawcett and Blachford			8.4	
1900	Lenzmann		22.0		
1903	Huntington	0.5			
1904	Holmes			6–10	–1.0
1905	Kelly and Hurdon			9–10	0.6
1905	Weaver (Kelly and Hurdon)		21.5		
1905	Blake (Kelly and Hurdon)		24.0		
1909	Nowicki			8.4	0.7
1913	Deaver	1.0	23.0	8–9	0.3–0.5
1918	Lewis	2.0	20.0	8.3	
1920	Lake		29.4		
1923	Arthur Robinson	1.8	23.0	9.2	0.6
1923	Piersol	1.0	24.0	8.4	
1924	Davis			8.75–10	0.6
1927	Royster	2.5	29.4	7.5	
1929	Henke and Lubarsch		28.0	9.5 at age of 20–30	

* Submitted for publication June 30, 1931.

normally are longer in the Negro race than those found among his white patients. The longest appendix on record in the literature was one reported by Grauer,[10] in 1890. This specimen was 33 centimetres long, after being fixed in solution of formaldehyde. The next longest specimen was one reported by Lake,[16] in 1920; it was 29.4 centimetres long and was obtained from a Negro aged twenty-two years, who had had symptoms referable to the lower part of the abdomen during the previous year, and had suffered sudden acute exacerbation of chronic appendicitis with perforation of the tip. The next longest appendix was reported by Henke and Lubarsch,[11] in 1929, it was 28 centimetres long and was found at necropsy of a man aged forty years who had died of a disease unrelated to the appendix.

The length of the appendixes in my series which represents 4,680 specimens removed from post-mortem material are given in Table II. It may be noted that approximately 61 per cent. of specimens were between 6 and 9 centimetres long. The extremes of length were 0.3 and 24.5 centimetres; the average length was 8.21+ centimetres. The average length of the appendixes of the male was 0.68+ centimetre longer than that of the female. One full-term, normally developed fetus (stillborn) was reported as not having an appendix.

TABLE II

Length of the Appendix in 4,680 Specimens

Length, Centimetres	Specimens	Per Cent.	Length, Centimetres	Specimens	Per Cent.
1	12	0.26	12	174	3.72
2	44	0.94	13	122	2.60
3	89	1.90	14	100	2.14
4	214	4.57	15	75	1.60
5	322	6.88	16	36	0.79
6	482	10.30	17	20	0.43
7	733	15.66	18	11	0.23
8	864	18.46	19	6	0.13
9	783	16.72	20	1	0.02
10	358	7.65	24.5	1	0.02
11	233	4.98	Totals	4,680	100.00

The longest appendix in my series was observed in a man aged seventy-six years, whose weight was 122 pounds (55 kilograms) and whose height was 177 centimetres. He died of a disease entirely unrelated to the appendix and, so far as could be learned from relatives, he had never had abdominal pain which might be construed as being referable to the appendix. The retrocecal position of this appendix and the intimate adhesion to the posterior wall of the cæcum is shown in Fig. 1. Its length after being fixed in formalin was 24.5 centimetres; its tip reached to the hepatic flexure of the colon.

The first comprehensive study made of the position of the appendix was completed by Gladstone and Wakeley,[9] in 1924, who studied 3,000 anatomic dissections. Previous to this, other authors had stated their belief, from observations at necropsy or operation, that the majority of appendixes are situated anteriorly, that they are free and hang over the brim of the pelvis.

Gladstone and Wakeley concluded that 0.9 per cent. were anterior or preileac, 0.5 per cent. were splenic or post-ileac, 27.5 per cent. were pelvic, lying on the psoas major muscle near or hanging over the brim of the pelvis, 1.86 per cent. were subcecal and beneath the caput ceci, 69.2 per cent. were postcecal and retrocolic, and 0.033 per cent. (one case) were ectopic. The position of the appendix in this series is shown in Table III. Three thousand six hundred seventy-six specimens (78.5 per cent.) were situated anteriorly, and 1,004 (21.4 per cent.) were retrocecal. These observations agree substantially with statements made by other observers.[1, 4, 5, 11, 14, 18, 21, 24, 25, 27]

FIG. 1.—Posterior aspect of regions of the ileocecal and ascending colon. The appendix was 24.5 centimetres long when fixed in solution of formaldehyde and extended to the hepatic flexure of the colon. It was intimately adherent to the posterior surface of the cæcum and ascending colon; its lumen was obliterated.

I believe that the only true retrocecal appendix is one that is either partially or entirely retroperitoneal and adherent to the posterior wall of the cæcum.

SUMMARY

A pathologic anatomic study is presented in which are summarized the length and position of 4,680 appendixes derived from post-mortem material. Seventy-eight and five-tenths per cent. of the appendixes were situated anteriorly and 21.4 per cent. were retrocecal. Approximately 61 per cent. were between 6 and 9 centimetres long. The appendixes of males averaged 0.68 centimetre longer than those of the females. The average length of all the appendixes was 8.2 centimetres. An unusually long appendix, 24.5 centimetres, was noted. In 50.8 per cent. of the cases, appendectomy had been performed.

TABLE III

Position of Appendix in 4,680 Specimens

Position	Specimens	Per Cent.
Anterior		
Free	3,262	69.68
Bound down in pelvis	370	7.90
Adherent to mesentery of terminal portion of ileum	44	0.94
Total	3,676	78.52

TABLE III—(*Continued*)

Position	Specimens	Per Cent.
Retrocecal		
Bound down and either partially or totally retroperitoneal	913	19.50
Free and subcecal	58	1.24
Bound down to retroperitoneal tissue behind terminal portion of ileum	33	0.71
Total	1,004	21.45

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SURGICAL POSSIBILITIES IN THE TREATMENT OF ANTERIOR POLIOMYELITIS *

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In no branch of orthopædic surgery are the recent developments in that specialty more spectacular than in the surgical treatment of chronic anterior poliomyelitis. To the average physician and surgeon infantile paralysis means helplessness, plaster-of-Paris and braces. To the average layman the picture is one of even more bitter despair. To the average charlatan it is a golden field with limitless possibilities of exploitation. Much confusion apparently exists not only in the lay but in the professional mind as to what may be expected from treatment, when it should be begun, and of what it should consist.

From the ideal standpoint the orthopædic treatment of poliomyelitis should begin the moment the diagnosis of the disease is made, and continue throughout the patient's lifetime. Practically, it usually begins when the acute symptoms have subsided and continues until the patient and surgeon are convinced that no further improvement is possible. The aims of orthopædic treatment are three: (1) The prevention of deformity; (2) the maintenance of muscular tone; (3) the maximum utilization of remaining muscular power by muscle transplantation and skeletal stabilization.

As to the pathology of the disease, it is an inflammation centering in and about the anterior horn cells of the spinal cord, and either by hæmorrhage into the cells or pressure about them depriving them of their function. The muscles whose efferent nerve impulses are transmitted through those cells suffer a flaccid paralysis. Fortunately, a majority of the cells lose their function from pressure rather than from actual destruction. Thus, as the inflammation subsides, power gradually returns to the secondarily affected muscles. If, however, during that period deformity had been allowed to develop, no degree of returning nerve power could restore normal muscle function.

Somewhat arbitrarily we have divided the disease into three phases—(1) Acute, (2) convalescent, and (3) chronic, and each phase has its different treatment.

The orthopædic treatment during the acute stage consists in the prevention of deformity, and, if I may use such a phrase, the immobilization of the affected area. The idea of being able to immobilize a segment of the spinal cord may seem fantastic. If we place the affected limbs in plaster-of-Paris we have assured ourselves that at least as few impulses as possible pass through, and by their passage irritate, the inflamed area. The same principle was applied by Hugh Owen Thomas to the treatment of peritonitis, and I

* Read before the New York Academy of Medicine, December 11, 1931.

have no doubt that it was handed on by him to Sir Robert Jones. Unless I am much mistaken, it is the only treatment that Sir Robert uses. It should undoubtedly be insisted upon until all muscular tenderness has disappeared. I think we all agree that muscular tenderness may be interpreted as a sign that the inflammation in the cord has not subsided. One of the strongest impressions left in my mind by the epidemic of 1916 was that the worst cases, and those in which the tenderness persisted longest, were those in which active treatment had been instituted too early.

When the acute stage has passed, we encounter from the therapeutic standpoint the most perplexing period of the disease. Most orthopædic surgeons have agreed to set two years as the period of potential recovery, and feel that, except for correction of deformity, no operative treatment should be undertaken during that period. During that two-year period the first essential is the prevention of deformity.

Deformity may occur (1) By the force of gravity; (2) by unopposed action of active muscles; (3) by habitual posture; (4) by functional use. The commonest example of the first is toe drop, caused by the attitude as the patient lies in bed, plus the weight of the bedclothes. Flexion deformity at the hip occurs by the unopposed action of the tensor fasciæ femoris muscle, which, curiously enough, is almost never completely paralyzed. Habitual posture, as when a completely paralyzed person sits about, is in itself sufficient to cause flexion contractions at the hips and knees. Functional use as a cause of deformity may be seen when a patient with weakened back or abdominal muscles sits up unsupported, and develops curvature of the spine. All these factors must constantly be kept in mind, and deformities thus prevented rather than cured. I am confident that the profession at large has learned many of these lessons, for since the war I have seen nothing to compare with the horrible deformities that I saw throughout the State in the epidemic of 1916.

The form of apparatus that is used will naturally vary according to the training and taste of a particular surgeon, but the end of all of them is the same, prevention of deformity and protection against gravity.

One of the most vexing questions is that of when to allow the patients up. There is no doubt that overfatigue of a weakened muscle is the greatest obstacle to its recovery. On this theory Doctor Lovett was accustomed to keep the patients off their feet indefinitely, while they had massage and muscle training. I feel myself, however, that the mental attitude of the patient is of the utmost importance, and that the depressing effect of such prolonged inactivity upon the patient must outweigh its benefit to a given muscle. Provided the affected muscles are properly protected, I cannot see that a small amount of exercise can be harmful. Even when accomplished only with the aid of braces and crutches the power of independent locomotion is of tremendous psychological value to the patient.

We have now arrived at the controversial phase of the disease. What is to be done during the two-year period that we have agreed to regard as that of potential recovery? Shall the patient have massage, muscle training, water-

borne exercises in a pool, various forms of electricity, chiropracty or osteopathy? I think the best thing to do is to fall back upon pathology. I take it for granted that a detailed muscular examination of the patient has been made. As the result of such an examination we know that certain muscles are completely, others partly, paralyzed. We can by no means thus far devised affect the diseased area in the cord, except by the itch of ill-advised activity to prolong its inflammation.

We have protected the remaining muscles by appropriate apparatus against the harmful effects of deformity and overfatigue. We know that paralyzed muscles when completely neglected atrophy, become stiff, and lose their tone, and that when a bone no longer functions in weight bearing it loses its calcium. Obviously, therefore, the muscles must be kept in the best of condition against the possible return of nerve power. Anything, therefore, that preserves their blood supply and is not so violent as to cause harm is beneficial.

Although no man by taking thought can add a cubit to his stature, we know that by taking appropriate exercises we can increase the size of a muscle. Suppose that half one's biceps muscle were paralyzed, one might by careful, persistent training build it up until the remaining half could do the work of the whole. Muscle training, under-water exercises and electricity all seek this end. The voluntary exercises, in which the patient's own brain is the activating force, are of far more value than the passive.

Water-borne exercises are certainly the most logical form of treatment. There is a bathtub in practically every home. This may be filled with water at from 85° to 90°, a little salt put in the water to increase its buoyancy, and the child placed in the tub and allowed spontaneously to move his limbs. If the doctor will then observe him carefully, he can, without particularly expert knowledge on his part, devise exercises for the affected muscles.

In the early stages of the disease electricity is dangerous. The only form of electricity that has been proved of any value is a form of current, such as the Bristow coil, which actually produces muscular contraction. Unless in the hands of a real expert, who knows how to stimulate one affected muscle at a time, there is great likelihood that all the muscles of an extremity will be stimulated at once, thereby cultivating the strong at the expense of the weak. Even an expert is apt to be carried away, and contract a muscle twenty times or more, when four or five contractions would be all that were indicated. The greatest of all dangers to a convalescent muscle is overfatigue from any cause. If there must be a choice between the two evils, too much treatment is far more harmful than no treatment whatever.

The attention of the profession in general should be called to two facts:— That the patient must not be sacrificed to his disease, and that the family must not be sacrificed to the patient. A patient is not likely to be greatly soothed by exercise in the relaxing luxury of a pool if it takes him two hours in a crowded bus to get to the hospital, and two more to get home again. Also, the paralyzed patient is but one unit in a family and sacrificing all the family resources to send him to a certain specialist, or away from home, perhaps, for a given form of treatment is mistaken kindness, and does most

harm to the recipient himself. From the very beginning emphasis must be placed upon making the patient independent, and not dependent upon the ministrations of his family or friends.

We now come to the third stage of the disease. We assume that every legitimate form of treatment has been tried, that a certain amount of improvement has been gained, but that it is agreed by all, including the patient, that he has come to a standstill.

If possible, before coming to this conclusion, he should have tried every form of treatment, excepting the positively harmful *quack* remedies, at his command. There is a tremendous psychological element in this, as in all diseases. Some patients are reluctant to face the truth, and drag themselves about from clinic to springs, and from springs to Europe for year after year. Others, more tough-minded, prefer to face the truth early. The sooner a given situation is faced, and the necessary adjustment made to it, the better it is for all concerned. I am strengthened in this belief by my experiences as Consulting Surgeon to the Veterans' Bureau. I think it is scarcely an exaggeration to say that the only veterans who have made a satisfactory adjustment to their situation are those who have suffered amputations. They recognize that their disability is final. The reaction that takes place is ably described by Lawrence Stallings in his account of his personal experience in his book, "Plumes."

In this connection, however, I must emphasize the great distinction that must always be kept in mind between treatment of paralysis of muscles of the upper and the lower extremity. The function of the lower extremities is to support the weight of the body, and any muscle to be an efficient aid to locomotion must very nearly approximate its normal strength. After various operations on the foot, for example, we frequently see return of power to the muscles of the toes. This gives the patient the greatest encouragement, but from a practical standpoint is of no use whatever. Indeed, it may be harmful, as such muscles may, being unopposed, have just enough power to produce deformity. In the upper extremity, however, the situation is quite different, as the slightest degree of power in the fingers or thumb may make a useless into a useful hand.

The principles of operative treatment are to make effective use of whatever muscular power remains, and by various forms of stiffening operations to substitute stiff but trustworthy for movable but unstable joints. Twenty years ago this end had to be accomplished by the use of apparatus. Now, however, operation has displaced braces, and internal been substituted for external splinting. In the shoulder it rarely happens that all the muscles attached to the scapula are paralyzed. The humerus may then be fused to the scapula so that the arm moves with the shoulder. The forearm may be suspended at a right angle on the arm, so that the hand may be brought to the face and various muscle transplantations may give a useful degree of motion to the fingers and thumb.

Paralysis affecting either the muscles of the abdomen or the back will, of course, result in curvature of the spine. The spine may be likened to the

mast of a boat, supported by four stays. If any or all the stays are removed not only does the mast become unstable of itself, but it is constantly subjected to the unopposed pull of what stay or stays remain, so that deformity is inevitable. There is, therefore, no good reason for delaying fusion operations on the spine after the expiration of the two-year period. One should never attempt to fuse the entire spine at one sitting. The fusion operation is difficult and severe, the subjects are unfavorable ones for operation, and one should always do too little rather than too much.

It might here, while I am dwelling on the severity of operative procedures, and the poor condition of the patients, be fair to paint with equal justice the other side of the picture. There is no more miserable spectacle than the paralyzed child who has been allowed to sit about, in whom deformities have developed unchecked. They are unable to make use of what muscular power they have, their circulation is bad, their bones are brittle and full of fat; if they have advanced curvatures of the spine their hearts are embarrassed and their lung capacity greatly decreased. They are mentally depressed. The general constitutional improvement that takes place in these patients as their deformities are relieved, their apparatus discarded, and as they regain the power of independent locomotion is nothing short of spectacular. As for the psychological effect, it is naturally incalculable. During the poliomyelitis epidemic of 1916, when I was serving as visiting orthopædic surgeon to the State health department, I saw what I suppose was as complete a collecton of cripples of all etiologies, ages, and degrees of deformities as has met any one's experience. Save for the idiots, I remember no one for whom something could not be done. The oldest case I ever treated was one of paralysis of thirty-nine years' standing in a man fifty-two years old. After not having set foot to the ground for thirty-nine years, he is now walking with braces and crutches, though he complains that he "bogs down" in the mud of the Spring thaws.

Another boy of eighteen with an untreated, congenital club foot was sent to the hospital from a small town on the St. Lawrence river with the local reputation of being not only a cripple but the village idiot. As after several operations his foot gradually approached a normal appearance his mentality greatly improved. After his last operation, when, to the average observer, his foot looked normal, he had to be discharged from the hospital for too pressing attentions to a night nurse. I hear from a local doctor that he is the Don Juan of the St. Lawrence. Whether or not that particular result was desirable may be questioned. No one could deny that it was striking.

It seems to me, therefore, that provided a surgeon has sense and experience enough not to kill his patient by too hurried or too enthusiastic operative procedures, that all these patients are entitled at least to a chance of relief.

Parents frequently object when they are told that the number of operations and the time in hospital cannot be definitely predicted. I am speaking, of course, of only the worst cases. The patients themselves never do. They realize that they have only one body, and plenty of time, and no matter what

their age, if they are told the truth in advance, they almost never complain.

In this connection I wish to point out on behalf of surgeons in general the necessity of telling children the truth. The screaming terrified ones who are so hard to handle are those who have been assured that the doctor wouldn't hurt them, and then have had their fracture reduced without an anæsthetic. That may be an extreme example, but we all know a few bitter surgical facts, for instance, that ether is unpleasant to take, and to come out of, and that after appendectomies bellies ache. If children are told those simple facts in advance they usually are delighted to find the reality less than their imagination painted. In any case, the average child wants to be brave, and given a fair opportunity he will be. But he bitterly resents being lied to.

The deformities affecting the lower extremities are flexion contractions of the hips and knees, knock knees, and every possible variety of deformity of the foot. These may all be relieved by fairly well standardized operative procedures. It is the practice in some clinics to perform fusion operations on knees for dangle or flail extremities. The object is to relieve patients of their braces. I have never performed the operation without previously making the patient live with his legs in plaster for a month or so to see what life with a stiff knee could be. As a result I have performed the operation for that particular disability only twice in all my experience. Also, an astragalectomy and backward displacement of the foot properly performed, so that dorsal flexion of the foot is checked at a right angle, will lock the knee in extension, so that in many cases braces are unnecessary.

What I desire to emphasize are the three sharply differentiated phases of the disease, and what we may hope may be accomplished by treatment in each phase. If one keeps the pathology of each phase always in mind, one is less likely to become confused in treatment. No matter how badly neglected the patient or how advanced the deformity, something may always be done toward improvement.

In favorable cases surgical treatment may entirely mask the effects of the disease. In worse cases it may enable the patient to discard apparatus. In the worst cases it can hold out the possibility of independent locomotion. The disease this year is not nearly so severe as in 1916. I have not seen for years the terrible deformities that I saw then all over the state of New York. Surely such an improvement must mark a beginning in the education of the public and the medical profession. Once they have an understanding of the nature of the disease, when it no longer seems the utterly mysterious thing that it does now, the people will no longer rush frantically *from quack to quack* sacrificing the fortunes of the family to any one who promises a cure.

The public should know that only a small proportion of patients who contract anterior poliomyelitis are paralyzed at all. Of those paralyzed a large proportion get well. Of those who do not, the ones who are faithful and systematic in following the doctor's orders over long periods of time may be greatly improved. Owing to the replacement of braces by surgery only a very small number need expect to look, feel or act like a cripple.

OPERATIVE TREATMENT OF PARALYTIC GENU RECURVATUM

By Willis C. Campbell, M.D., and Joseph I. Mitchell, M.D.
of Memphis, Tenn.

Genu recurvatum, or exaggerated hyperextension of the knee, may develop following acute anterior poliomyelitis when the hamstring muscles and the gastrocnemius muscle are paralyzed and the quadriceps muscle is active. The deformity may also result from a compensatory effort to fix

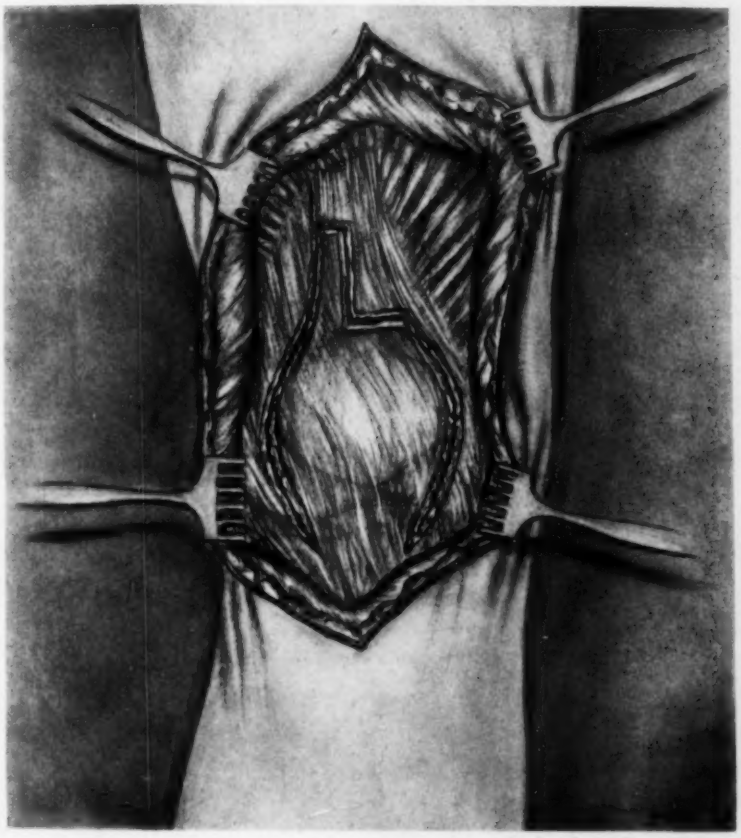

Fig. 1.—Incision over knee exposing the patella and the patellar ligament. The quadriceps tendon is divided by a Z-shaped incision.

the knee when all muscles of the thigh and leg are flaccid. Less frequently, hyperextension of the knee may occur as a sequel of spastic cerebral paralysis or of traumatic or other spinal-cord and peripheral-nerve lesions. A moderate degree of genu recurvatum is not incompatible with good function and under certain conditions may even be of advantage in stabilizing the paralyzed limb. If extreme hyperextension is present, however, standing and

walking become difficult or impossible without the aid of a brace or other apparatus.

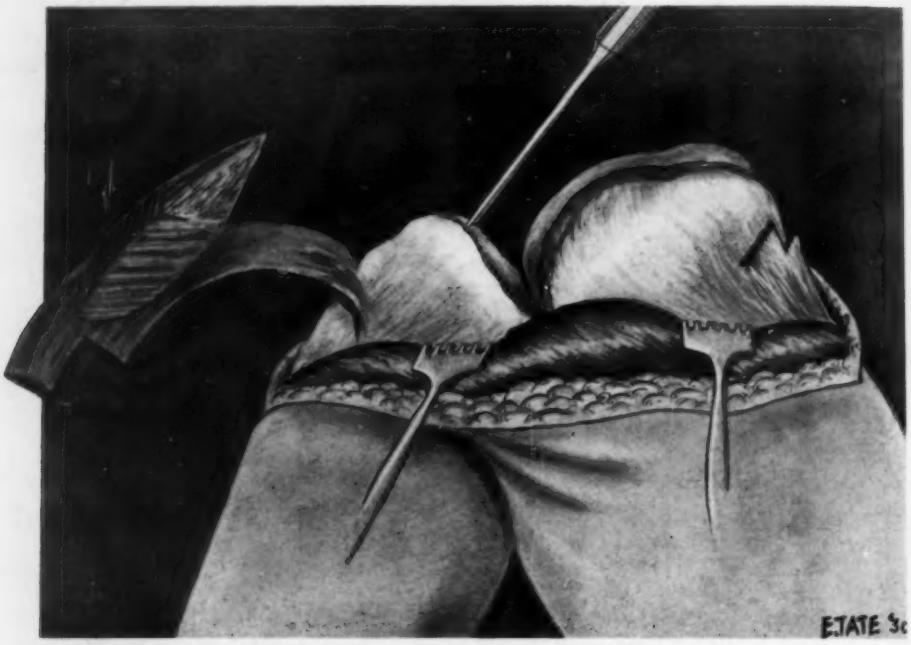

FIG. 2.—The patella is retracted downward and the cartilage and fibrous tissue are removed from the lower third of the patella. An osteotome is used to form a receiving cavity on the tibia.

An operation for the correction and prevention of hyperextension of the knee was described by one of us (W. C. C.) in 1918.[1] The mechanical prin-

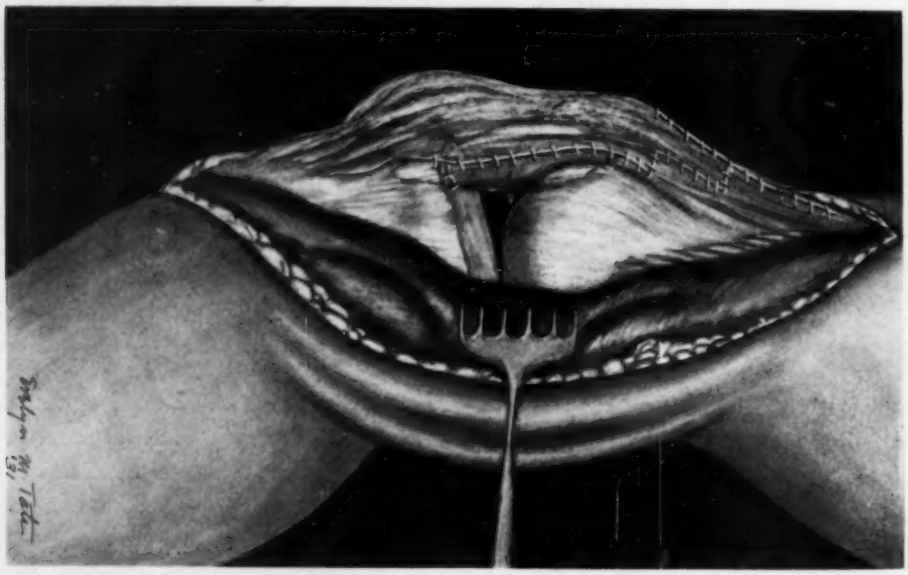

FIG. 3.—The patella is inserted into the cavity and sutured in position. The quadriceps tendon is reunited and the joint capsule closed. Note the bulging forward of the redundant patellar tendon.

ciple of the operation is to unite the lower end of the patella to the anterior aspect of the tibia; the upper two-thirds of the patella are left free to articulate with the femoral condyles when the knee is extended. A stop-joint is thus formed which prevents hyperextension of the knee in the same manner as the olecranon process of the ulna blocks hyperextension of the elbow. The description of this operation is believed to have been the first recorded instance in which a bone block was used to limit joint motion in a paralyzed limb, and it was from this procedure that the bone-block operation for drop foot was later evolved.

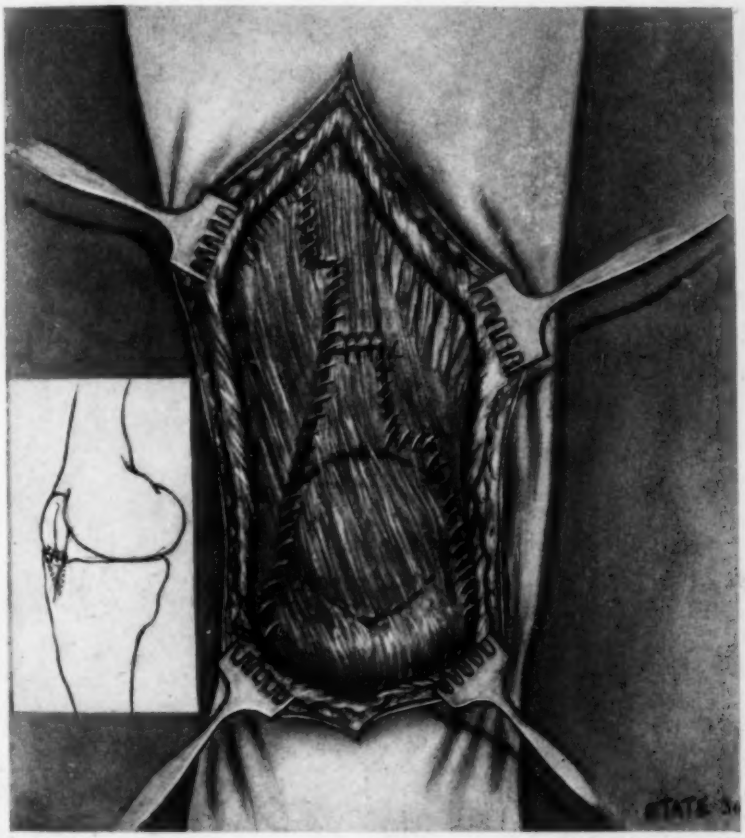

FIG. 4.—Method of suturing the quadriceps tendon after lengthening. The insert shows how the patella in its new position falls into the intercondylar notch to block extension of the knee-joint.

The technic of the operation as first described is as follows: A linear incision five or six inches in length is made over the patella and patellar ligament. The incision extends through the skin and superficial tissues which are retracted. The quadriceps tendon is divided above the patella by a Z-shaped incision. (Fig. 1.) The capsule of the knee-joint on either side of the patella is then incised and the patella retracted downward (Fig. 2), exposing the interior of the joint. The ligamentum muscusum is divided and a portion of the infrapatellar fat pad is excised. The cartilage covering the

lower one-third of the patella is removed to the spongy bone. The patellar tendon and the periosteum are stripped from the anterior surface of the patella for a distance of one-half to three-quarters of an inch. A cavity is then made on the upper anterior aspect of the tibia by driving an osteotome vertically downward and prying forward the portion of the tibia anterior to the chisel. The patella is inserted into the depression on the tibia thus made, and the periosteum of the patella is sutured to the periosteum of the tibia about the margin of the cavity. (Fig. 3.) The quadriceps tendon is reunited at neutral tension, the joint capsule sutured and the wound closed in

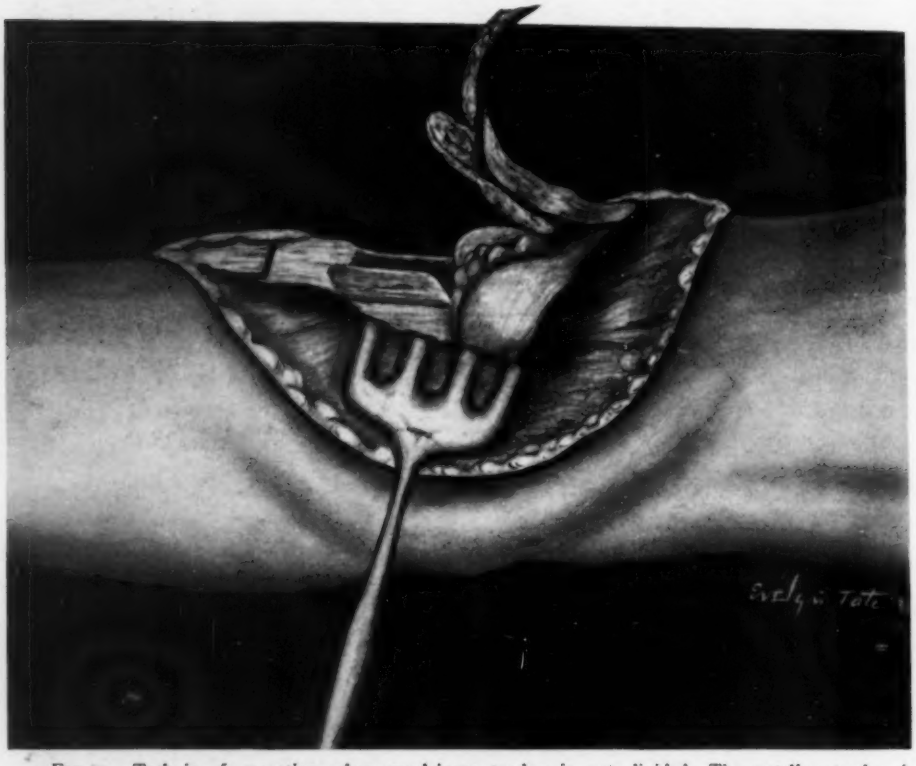

FIG. 5.—Technic of operation when quadriceps tendon is not divided. The patellar tendon is retracted upward and a flap of bone raised from the tibia, forming a shallow depression at this point.

layers. (Fig. 4.) A cast is applied holding the knee at 160° flexion. After eight weeks a brace with a stop-joint at the knee is applied and worn until röntgenograms demonstrate that bony fusion is complete. The position in which the knees become blocked must be carefully observed and controlled throughout the period of post-operative convalescence. Complete extension or even slight hyperextension is essential. If the patella stops extension of the tibial on the femur before the position of complete anatomic extension is secured, the paralyzed limb will still be unstable and the knee will flex when weight is borne on the limb unless the patient supports his thigh with his hand.

A modification of the original technic, in which the quadriceps tendon is

FIG. 6.—Röntgenogram of Case I, seven years after operation.

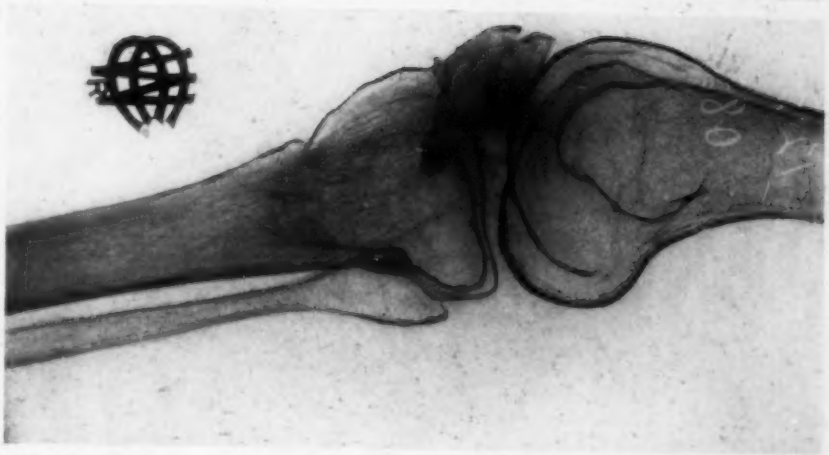

FIG. 7.—Röntgenogram of right knee. Case II, one year after operation.

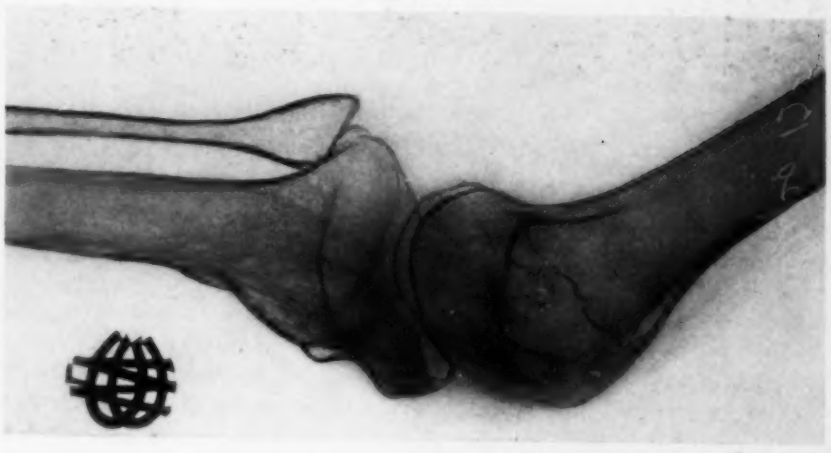

FIG. 8.—Röntgenogram of left knee, Case II, one year after operation.

not divided, has been employed by one of us (J. I. M.) in three cases. A longitudinal or transverse incision is made over the insertion of the patellar tendon. (Fig. 5.) The attachment of the tendon is freed from the tibial tubercle and the tendon and patella retracted upward, the infrapatellar fat pad being dissected from the tendon and pushed backward into the joint. A flap of bone is raised from the upper aspect of the tibia and a shallow depres-

FIG. 9.—Photograph of Case III, showing bilateral genu recurvatum.

FIG. 10.—Same as Fig. 9, eight months after operation.

sion made in the bone at this point extending up to the articular surface. The lower one-third of the patella is denuded of cartilage and tendinous attachments and this portion of the bone placed in contact with the denuded area on the tibia. The flap of bone is replaced and the fragments of cancellous bone, removed in making the excavation, are packed around the lower margin of the patella. The tendon is pulled taut and the patella maintained

in its new position by suturing the tendon to the periosteum of the tibia at a lower level.

Recently Mayer[2] has described a modification of the operation in which a bone graft from the tibia or femur is placed in contact with the upper surface of the tibia and the denuded patella. He reports excellent functional results from the procedure. Gill[3] has also reported satisfactory result following the construction of a strong check ligament from the posterior portion of the periosteum of the femur and the fascia lata. Other procedures which have been employed are arthrodesis of the knee and supracondylar osteotomy of the femur.

FIG. 11.—Röntgenogram of Case V, one year after operation.

CASE REPORTS.—CASE I.—A girl, aged fourteen years, was examined December 2, 1919. Following an attack of infantile paralysis when three years old both legs were flaccid and since that time the girl had walked only with crutches. The examination showed atrophy and loss of muscle power in both legs with genu recurvatum on the left side and genu valgum on the right. An arthrodesis of the tarsal joints of the left foot and osteotomy of the right femur were performed January 23, 1919. The left knee was operated upon March 25, 1922. Bony fusion of the patella to the tibia was secured with improvement in function (Fig. 6) although the patient has continued to wear a brace on the left leg and uses crutches.

CASE II.—A girl, aged fifteen years, was examined August 28, 1923. Following an attack of infantile paralysis when eight years old, both lower extremities were almost flail. On examination she presented bilateral equinovarus deformity, exaggerated hyperextension of both knees and a severe paralytic scoliosis. On September 15, a triple arthrodesis and drop-foot operation was performed on the left foot; at the same time the routine fusion of the patella to the tibia was carried out on the right knee. On December 7, a similar operation was performed on the left knee and the deformity of the opposite foot was corrected. Still later, the spinal curvature was partially corrected and the dorsal region of the spine fused. Bony ankylosis of the patella to the tibia was secured in each instance with considerable improvement in function of the knees. At the present time, the girl uses crutches, except when walking very short distances, because of the generalized muscular weakness, but the knees are stable (Figs. 7 and 8) and she does not complain of pain or other inconvenience.

CASE III.—A boy, thirteen years of age, was admitted into the hospital October 31, 1923. When six years old he had had an acute febrile illness which was not diagnosed, but which was followed by weakness and progressive deformity of both legs. (Fig. 9.) Examination showed muscular atrophy and flaccid paralysis of both lower extremities

with pronounced recurvatum of both knees which interfered greatly with locomotion. November 2, both knees were operated upon. On the right side the routine technic was employed; on the left leg an osteotomy of the femur was done, removing a wedge from the supracondylar area with the base posteriorly. The stability of both knees was improved. (Fig. 10.) However, the functional result on the right leg, in which fusion of the patella to the tibia was accomplished, was superior to that of the left leg, in which the osteotomy was performed.

CASE IV.—A girl, sixteen years of age, was seen June 3, 1924. She had had acute

FIG. 12.—Photograph of Case VI, showing genu recurvatum and equinus deformity of the left foot.

FIG. 13.—Same as Fig. 12 ten months after operation.

anterior poliomyelitis during infancy. In 1920 flexion contracture of both hips had been corrected by operation. Examination showed extensive paralysis of both lower extremities, the right leg being practically flail below the hip. There was exaggerated hyperextension of the right knee when weight was borne, necessitating the use of a brace on that leg. The operation for fusion of the right patella to the tibia was performed June 4, and an arthrodesis and drop-foot operation was performed on the left foot. The results of both operations were good, the patient being able to discard her brace, and she now walks with a less noticeable limp.

CASE V.—A girl, aged seventeen years, was examined February 27, 1928. At the age of two years she had contracted an acute febrile illness resulting in extensive flaccid paralysis of both lower extremities. The left leg could be hyperextended at the knee; there was slight voluntary power in the hamstring muscles, but the quadriceps muscle and all muscles below the knee were completely paralyzed. The left foot was contracted in a position of equino varus. The right leg was flail and there was a right talipes varus. There was also a right dorsal, left lumbar scoliosis of paralytic origin. The first operation, which was performed on March 1, consisted of an arthrodesis and bone block on the left foot. On April 12 an arthrodesis and drop-foot operation was performed on the right foot and at the same time the left patella was fused to the tibia. The technic of the operation in this case was modified in that the patella was exposed from below and the quadriceps tendon was not lengthened. The immediate and eventual results of the orthopedic operations were satisfactory from clinical and röntgenogic standpoints. (Fig. 11.) On the day following the second operation, the patient developed an acute abdominal condition which was diagnosed appendicitis; an emergency appendectomy was performed by the general surgical consultant. Following this operation complications arose making other abdominal operations necessary and keeping the patient practically bedridden for the rest of her life. She died at home thirteen months later from what was reported by her attending physician to have been a brain abscess. Unfortunately, a post-mortem examination was not obtained.

FIG. 14.—Röntgenogram of Case VII, two months after operation.

CASE VI.—A Negro boy was first seen August 30, 1922, at the age of three years. The history suggested a cerebral birth injury from a difficult instrumental delivery during which the left humerus was fractured. Spasticity with adduction contracture of both legs prevented the child from walking and there was, in addition, equinus deformity of both feet and dorsal dislocation of both hips. The dislocation of the hips was reduced by closed manipulation. After dismissal from the hospital, the child was not brought back for observation until June 4, 1928. The examination then showed extreme recurvatum of the left knee. The knee could be hyperextended to 100°; flexion of the joint was limited to about 10° past the straight position. The left foot was contracted in the equinus position. (Fig. 12.) On the right side the thigh was adducted, externally rotated and flexion of the knee was limited to 90°. There was also a right dorsal left lumbar scoliosis. Röntgenograms on this date showed the head of each femur to be in the acetabulum. Operative treatment was advised but was not accepted until February 2, 1929, at which time the left tendo achillis was lengthened, correcting the equinus deformity. A brace with a stop-joint at the knee was then applied and flexion of the knee gradually developed. On February 27, 1930, the left patella was arthrodesed to the tibia, the technic employed being the same as that used in Case V. When last observed, July 20, 1931, fusion of the patella was not solid, but the function of the leg was greatly improved. (Fig. 13.) Only slight hyperextension of the knee was demonstrable and flexion was possible to almost 90°. The boy walks with crutches.

CASE VII.—A girl, aged sixteen years, was examined July 26, 1930. As a result of

infantile paralysis when two years old, the left leg was almost completely flaccid. The limb was two inches shorter than the right with a dangle foot and hyperextension at the knee. A tarsal arthrodesis and drop-foot operation was performed July 29. The patella was arthrodesed to the tibia on October 7. In this case as in Cases V and VI the quadriceps tendon was not lengthened. Following eight weeks' immobilization, the patella was clinically fused and the röntgenogram showed good approximation and new bone production. Motion in the knee-joint is restricted to about 45° flexion, which will probably increase. (Fig. 14.) The knee blocks in the extended position, but the patient will continue to wear a brace for several months.

CONCLUSIONS

Paralytic genu recurvatum results in most instances from a combination of muscular weakness and the static force of weight-bearing.

When due to anterior poliomyelitis, severe degrees of hyperextension of the knee occur usually in those individuals in whom the paralysis is of severe grade and wide distribution. The deformity is often associated with other deformities in the lower extremities and trunk.

The operation of fusion of the patella to the tibia in selected cases offers a technically simple and reliable method of treatment. Seven cases are reported, in one of which the operation was performed on both knees. The functional results of the operation are superior to those obtained from supracondylar osteotomy of the femur and are believed to be more permanent than can be secured from any form of ligamentous fixation. The additional surgery required for employing an autogenous bone graft is thought to be unnecessary. Should it be deemed inadvisable to lengthen the quadriceps tendon, the patella can be approached from below without entering the knee-joint proper, the procedure then being practically extra-articular.

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CHRONIC TUBERCULOUS POLYARTHRITIS

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There is scarcely a subject in medicine so difficult of etiological interpretation as chronic arthritis. Although a great deal of clinical and experimental data are available in which highly selective strains of streptococci have been incriminated, yet in the symptom complex designated as rheumatoid or chronic infectious arthritis the exciting cause can, at best, only be surmised.

It is well known that a specific bacterial excitant from a known focus of infection may provoke an acute polyarthritis, maintain possession of the joints and produce the chronic, inflammatory changes.

In many instances, the removal of the local focus harboring these organisms and the administration of specific vaccines are followed by a freedom from recurrences and the relief of the patient from the joint disabilities. On the other hand, there are many cases in which the clinical manifestations in the joints may be indistinguishable from those of the favorable group; the removal of the chronic local infection, if found, fails to free the patient from the arthritis and the disease progresses. All of us are familiar with such cases.

The reasons offered for these unfavorable results are still controversial and speculative. Some attribute it to the persistence of foci of infection in inaccessible regions; others have advanced the theory that the joints themselves may act as secondary foci of infection. This is hardly tenable since there has been no substantial proof to indicate that joints can act in this manner. It is held by an important French school, headed by Poncet and Leriche, that a large percentage of cases of rheumatoid arthritis is due to the action of attenuated strains of tubercle bacilli or toxins derived from some latent tuberculous focus in the respiratory system or elsewhere. According to these investigators, the inflammatory reactions, excited by this form of tuberculous infection, are indistinguishable clinically and pathologically from rheumatoid arthritis.

I am in accord with these views, as will be illustrated by a report of a small series of cases recently studied.

Historical.—Bonnet, in 1845, called attention to the transformation of rheumatic joints into true white swelling. The medical writing of this period conveys the impression that the clinicians were aware of an ill-defined relationship between tuberculosis and chronic arthritis.

In 1854, Charcot crystallized these views, calling attention to the great mortality from tuberculosis among patients suffering from chronic rheumatism. Again, in 1864, he emphasized the important part that scrofula played in the family history of patients suffering from chronic, progressive arthritis and remarked upon the incidence of pulmonary tuberculosis in such cases.

In the early 'eighties, Grocco, an Italian clinician, pointed out that tuberculous patients may develop joint disease without tubercles, cold abscesses or complete destruction of the joints. In 1892, he reported nine cases of tuberculous rheumatism and commented upon the uselessness of salicylates in such cases.

Poncet's first contribution, entitled "Chronic Tuberculous Rheumatism," was presented to the French Surgical Congress in 1897. His view met with great opposition. The existence of chronic tuberculous polyarthritis was denied. Patient and painstaking accumulation of laboratory and clinical facts with their careful presentation before numerous French societies stimulated a clinical interest in this subject and it has won a foothold as clinical entity in France and Germany.

In 1909, Poncet and Leriche published their classic contributions on "Tuberculous Rheumatism and Inflammatory Tuberculosis," and in the past decade many articles and case reports on the subject have appeared in the foreign literature.

In American literature one is impressed by the paucity and barrenness of statistics regarding the relationship between tuberculosis and chronic arthritis. In looking over the statistics furnished by the arthritic clinics in various parts of this country practically no mention is made of tuberculous rheumatism. Neither is any statement made regarding a differentiation between tuberculous polyarthritis and the ordinary infectious forms. It is highly probable that, included in their statistics, a certain percentage could be isolated, providing special examinations such as arthrotomy, biopsy studies and guinea-pig inoculations were performed.

A review of the more recent literature gives us an impressive array of case reports indicating that tuberculous polyarthritis is not uncommon. Brief mention is made of the following contributors to the subject: Edsall, Harvey and Hall, Mouriquand, Mitchels, Valentin, Betchov, Reitter and Lowenstein, A. M. Cohn, R. Gautenberg, J. J. Viton, J. A. Cruciain, and L. Charosky and MacKinnon. These references are enlightening and show convincingly the reality of this clinical entity.

It should be emphasized that chronic, tuberculous polyarthritis is, in its evolution, clinical behavior, anatomical and pathological structure, and by X-ray, indistinguishable from the streptococci arthritides.

Early and even advanced cases are exceedingly difficult to place etiologically and hence are the source of a high percentage of error.

We are in the habit, because of our academic training, of looking upon tuberculous arthritis as a systemic disease with a tendency to monarticular localization, the clinical and pathological characteristics of which need not be detailed here.

When the patient exhibits the disease in a multiple form, which may simulate, clinically, ordinary chronic arthritis, we are prone to view the tuberculous origin with skepticism, or, more likely, not to consider it at all because of our preconceived notions of bone and joint tuberculosis in general.

This report is concerned with records of four cases of chronic, tuberculous polyarthritis of long standing, the discovery of whose true nature was made possible only by arthrotomy, tissue study and animal inoculations.

CASE I.—D. B., male, aged forty-eight, was admitted to the hospital July 8, 1928, suffering from chronic polyarthritis of about eight months' duration. The onset was sudden and the cause unknown. Dental extraction and tonsillectomy six months previously failed to effect relief or a cure. The patient had had chronic, pulmonary tuberculosis for many years; activity was evidenced by the presence of tubercle bacilli in the sputum. Family history unimportant and irrelevant.

He was emaciated, anæmic, male adult weighing 125 pounds. The mouth was œdentulous and tonsils were enucleated. His chest was of the phthisical type; both apices were involved in a tuberculous process, confirmed by physical and X-ray

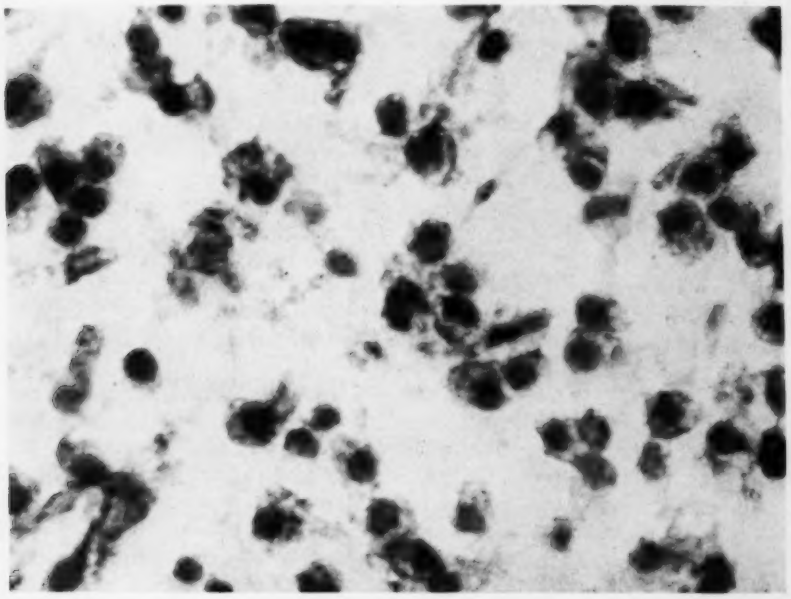

FIG. 1.—Peculiar large cell infiltration with eccentric nuclei and acidophilic cytoplasm. Gelatinous œdema in a case of tuberculous polyarthritis.

examinations. The heart was normal in size, shape and position; tones were of poor quality—no murmurs were audible. The abdomen was negative. The extremities exhibited polyarthritis of the infectious type with periarticular proliferation, limited motion, marked arthritic muscular atrophy and typical deformities. The involved joints included the shoulders, elbows, wrists, phalanges, knees, ankles and tarsals.

The knee-joints were swollen and fluctuated on palpation. Diagnostic tap revealed a cloudy, yellow exudate, which, upon microscopical examination, proved to be negative for acid-fast bacilli and sterile on culture for other organisms. The X-ray examination of the knee-joints showed bone atrophy; normal outline and narrow spaces.

Laboratory studies showed sputum positive for tubercle bacilli; urine contained traces of albumen and casts; blood revealed a secondary anæmia; Wassermann test, negative, and the synovial fluid showed a leucocyte count of 80 to 100 polymorphonuclears per H.P.F. The gastro-intestinal study, including X-ray examination, showed a displacement of the sigmoid to the right. Fæces were negative for parasites, ova and pathogenic bacteria. The prostatic smear showed three to five pus-cells per H.P.F. (Fig. 1.)

The patient was treated along conventional lines by salicylates, intravenous injections of neoarsphenamine for about six weeks, during which time his temperature ranged between 99° and 101°; pulse 80 to 110 and respiration 24 to 28. No improvement was noted under this treatment.

August 17, 1928, an arthrotomy of the right knee was performed through the split patellar route. The findings at operation were a thickened, congested synovial membrane, marked villous hypertrophy, fibrillation of the articular cartilages, slight pannus formation, disintegration of the internal semilunar cartilage and slight erosion of the articular surfaces of the tibia. A total synovectomy was performed by block dissection; the wound was closed in layers without drainage and a plaster case applied from toes to mid-thigh. The case was removed ten days after operation. The wound healed by primary union. The patient was discharged four weeks after the operation and sent to a convalescent home for post-operative care.

The patient re-entered the hospital on December 24, 1928, in excellent condition; right knee showed a normal outline but marked restriction of movement. A synovectomy was done on the left knee with findings similar to those noted at the first operation. Post-operative course was uneventful, and the wound healed in two weeks.

A diagnosis of tuberculosis polyarthritis was made based upon the histological report furnished by Dr. Benjamin Gouley, which is as follows:

The synovial membrane is thickened by œdema and cellular infiltration. No definite tubercle or caseation is found, but the entire section is invaded, both diffusely and locally around blood vessels, by large endothelial cells, having rather deeply stained nuclei, pale and sometimes acidophilic cytoplasm. The œdema sometimes has a gelatinous or mucoid appearance. Occasional lymphocytes are seen, but generally only the large endothelial cell is present. Another striking feature is the intimal thickening of small arteries. It is not an inflammatory lesion, but rather a swelling and vacuolization of the media and intima and is identical with the vascular changes seen in tuberculosis in other viscera.

This patient has been recently discharged from the Hamburg Sanitorium after having been there for about six months. The knee-joints have retrogressed and are now practically in the same condition as they were prior to operation. They are swollen, boggy, painful and tender. Aspiration disclosed typical tuberculous pus. Results of the guinea-pig inoculation are not yet reported.

Case II.—H. G., aged thirty-seven, male adult, first entered the hospital June 8, 1927, with the chief complaint of swollen joints, dyspnœa and generalized œdema. These symptoms were of four months' duration, during which time he had been continuously confined to bed.

Previous Medical History.—In 1917 while in military service in France he was confined to the regimental infirmary for rheumatism and kidney trouble; under treatment these conditions improved. In 1919, he had a recurrence of the above diseases which confined him to bed for four months. During the past ten years he had recurrent attacks of polyarthritis which responded to treatment.

He is single, denies venereal infection, smokes excessively and has been a hard drinker at times; family history is unimportant.

He is emaciated, anæmic, male adult. His face is swollen, eyelids are puffy. Teeth are bad and tonsils diseased. Crackling râles are heard over the entire chest. Impaired resonance and distant breath sounds are heard over both bases indicating a pleural effusion. The heart exhibits increased dullness to the left; apex beat in sixth interspace; heart sounds are distant and muffled. No murmurs are audible. These physical signs indicate pericardial effusion. The abdomen is negative. The shoulders, elbows, wrists, fingers, knees, ankle and tarsal joints are involved in an arthritic process of the chronic infectious type. The wrist and phalangeal joints are swollen and restricted in mobility. The knees are swollen, globular in contour, fluctuate on pressure; patellæ float, and mobility is restricted and painful. The ankle and tarsal joints are rigid. There is a

marked, generalized arthritic muscular atrophy. The skin over the lower limbs is waxy and glazed in appearance and pits on pressure.

Laboratory Examination.—Urine revealed albumen, both granular and hyaline casts; blood chemistry, normal; blood count indicated secondary anæmia; Wassermann test, negative; X-ray of chest showed extensive, peribronchial and slight alveolar infiltration throughout extending to the apices. The hilus regions are markedly infiltrated and contain a few calcified lymph-nodes. The left base is obscured by pleurisy covering the diaphragm, suggesting an effusion. A small pleural effusion on the right side obliterates the right costophrenic angle. The heart is enlarged to the left; aorta is normal.

He remained in the hospital for about one month during which time the temperature ranged between 98° and 100°; pulse 90 to 120, respirations 28 to 32. Under treatment he improved slightly and at the end of a month left the hospital against advice.

During the succeeding fifteen months he re-entered the hospital on four different occasions. On one of these admissions his diseased tonsils and teeth were removed but these measures failed to benefit him in any way. At one time because of the multiple involvement of many serous membranes (pleura, pericardium and synovial), a diagnosis of Pick's disease was made.

The knee-joints were tapped several times, yielding a serous exudate which showed no organism on culture or smear; no animal inoculations were performed.

On one occasion oxygen was injected into the knee and followed by X-ray. The findings were incomplete filling of the subfemoral bursa due to adhesions or masses in the sac, irregular and narrow joint spaces, suggesting cartilaginous absorption, and marked atrophy of the bones.

November 12, 1929, the right knee-joint was explored through a Fisher incision and a total synovectomy was performed. The findings at operation were considerable fluid and a large quantity of débris, cheesy in character, filling the cavity of the joint. The synovial membrane was markedly thickened and the villi profuse; the lateral margin of the articular surfaces were irregularly covered with a thick layer of granulation tissue. Irregular areas were seen over the lateral condyle and the mesial surfaces of the tibia, exposing bare bone. The internal meniscus was disintegrated and the crucial ligaments destroyed; large necrotic villi were present between the joint's surfaces. The synovial membrane was completely excised and the wound closed in layers without drainage.

The post-operative course was uneventful; healing was rapid and the results were excellent. Normal contour was restored; motion was considerably restricted.

Pathological Report.—The specimen contains a great many membranous pieces of tissue, having one smooth and glistening and another, rough, ragged and uneven surface. These tissues represent parts of a capsule and synovial membrane. There are a great many pieces of tissue of varying size and shape which can be roughly divided into two groups: The one consisting of very soft tissue which is friable and almost snow-white in color. When torn to pieces it has the appearance of flakes of soap. This part weighs approximately 27.2 grams. The other group consists of pieces of tissue, some of which are lemon-yellow in color, others pinkish and gray. The pink and gray surfaces are smooth and glistening, apparently lined with a serous membrane. The yellow specimens have the characteristics of fat tissue.

Microscopic Examination.—The membranous specimens show a dense infiltration with round cells; in some of the areas there is a very marked proliferation of endothelial cells. In several fields typical giant cells are seen. The picture is characteristic of chronic, tuberculous inflammation. There is also a very marked, acute inflammation as shown by numerous neutrophilic leucocytes. The snow-white, amorphous pieces of tissue consist of a fibrinous and leucocytic exudate. All sections show a large number of plasma cells, and large mononuclear cells of various types.

Further comment by Dr. Benjamin Gouley is as follows: This case shows histologically a typical caseous necrosis of the articular tissue (pannus formation) and it is

interesting to find such pathology in a joint that clinically presented the picture of ordinary arthritis deformans.

December 14, 1929, a synovectomy was performed on the left knee with findings similar to those in the previous operation. The post-operative course was uneventful. The knee-joints after these operations, while considerably restricted in mobility, gave rise to practically very little pain. Their contour was normal. Weight-bearing was commenced two months after admission and for the first time in many months he was able to stand on his feet. He gained in weight and his entire mental attitude changed from a cranky, cantankerous, irritable patient to a hopeful, buoyant individual. An interesting

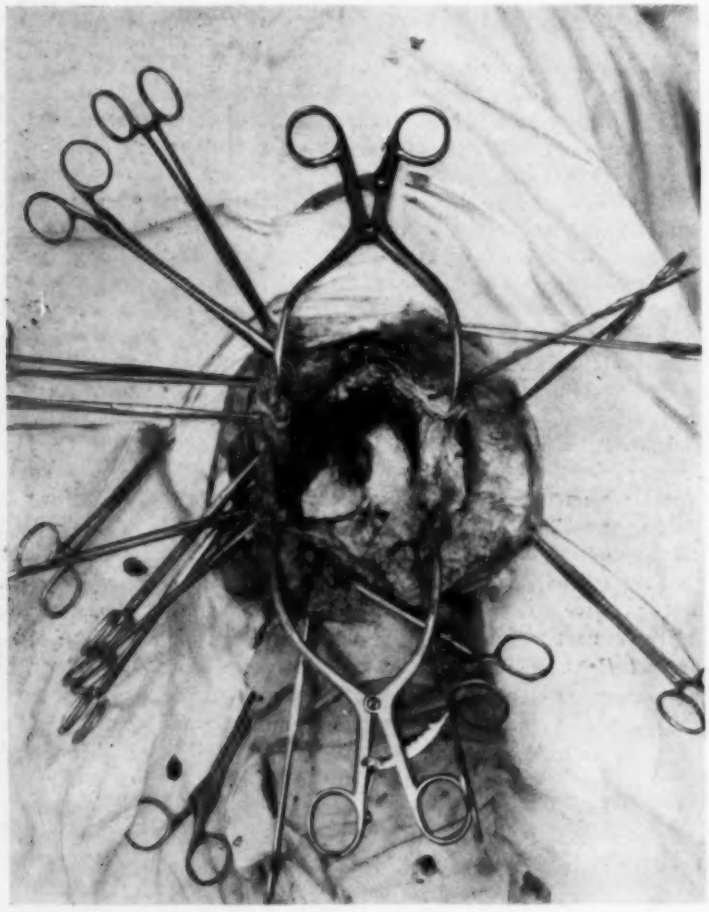

FIG. 2.—Tuberculous polyarthritis. Exposure of knee-joint showing cartilaginous erosion of external condyle of left femur and marked synovial thickening.

note in this case is the effect of these operations upon his heart. The heart action, which had been persistently hurried and weak throughout his entire hospital stay, became slower, more regular and improved in tone. His pulse rate, which had always ranged between 100 and 120, prior to operation, now ranged between 80 and 90. He was referred for convalescent care and gained twenty pounds in two months.

During the past year this patient has been under observation in the pulmonary and orthopædic clinics of the hospital. Repeated sputum examinations have been negative for tubercle bacilli, although clinically he has pulmonary tuberculosis.

CASE III.—B. P., aged sixty-five, female, admitted to the hospital September 8, 1930, suffering from polyarthritis of about six years' duration. For the past six months the left knee gave a considerable amount of pain and disability, which failed to respond to conservative treatment, baking, massage, salicylates and the like. The wrists, fingers, knees and ankle-joints exhibited signs of a proliferative arthritis. The left knee contained fluid. She was a short, stout, aged female, with œdentulous mouth, tonsils enucleated, subcrepitant râles over both bases; heart enlarged to the left, sounds of poor quality. Abdomen negative.

Laboratory Examination.—Urine showed a trace of albumen. Wassermann test,

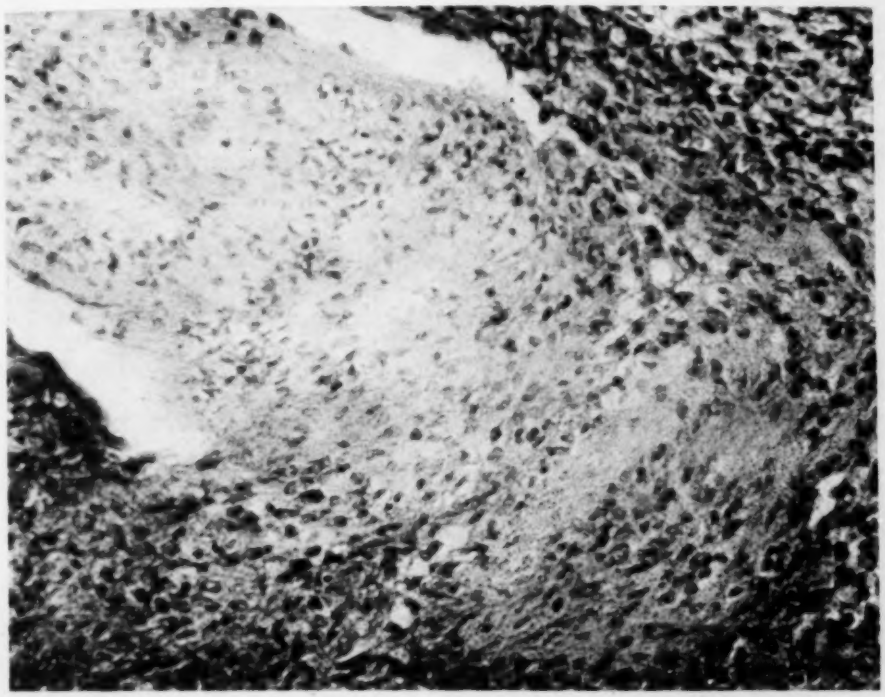

FIG. 3.—Conglomerate tubercle and granulation tissue in case of tuberculous polyarthritis.

negative; blood count, normal; blood chemistry, normal; X-ray examination of knee-joints revealed narrow joint space, absorption of articular cartilages, bone atrophy and marked soft tissue swelling.

Synovectomy was performed on the left knee in the usual manner; Fisher mesial incision. (Fig. 2.) Findings at operation: A large, necrotic, pedunculated fat pad occupied a position between the external condyle and the lateral articular surface of the tibia. Synovial membrane was markedly hypertrophied and congested. Lateral condyle was covered by a thick layer of pannus which extended over the articular surface, the removal of which exposed bare bone. The articular surfaces of the tibia exhibited absorption and necrosis in various regions. There was complete disintegration of the semilunar cartilages and the crucial ligaments were destroyed. Articular surface of the patella exhibited punched-out areas of cartilaginous absorption. The wound closed in the usual manner; cast was applied from toes to groin. The patient remained in the hospital nineteen days; wound healed by primary union. Follow-up in clinic shows that the left knee had marked restriction of motion with considerable disability and pain.

Histological report by Dr. Benjamin Gouley is as follows: The synovial membrane is markedly thickened by congestion, œdema and a diffuse cellular infiltration. The

œdematous infiltrate is filled with large cells, apparently endothelial with deeply staining eccentric nuclei. (Fig. 3.) In some fields lymphocytes form a large percentage of exudate, but the large cells predominate and often to the complete exclusion of any other cell. Their cytoplasm has a slight tendency to take the acid stain. In a few tags of tissue attached to the synovial membrane definite tuberculous pathology is present with caseous necrosis, tubercle formation and fibrosis. The small blood-vessels often show a marked thickening of their intima, leading to spontaneous occlusion as is often seen in tuberculous pathology.

Case IV.—F. K., aged forty-eight, female, was admitted to the hospital October 19, 1930, suffering from advanced atrophic arthritis of about ten years' duration. The present illness followed an incision of tonsillar abscess ten years ago. Until five years ago she was able to get around with some disability; for the past five years she had been bed-ridden. Several years ago she was in the hospital for about five months,

Fig. 4.—Tuberculous polyarthritis. Many joints involved.

where every accessible focus of infection had been removed but without improving joint symptoms.

She was an emaciated, middle-aged woman, weighing about 90 pounds. The right lung exhibited amphoric breathing over the right apex; bronchial breathing over the right, middle lobe. The left lung was clear. Heart was normal in size, shape and position. Sounds were of poor quality; no murmurs. The abdomen was negative. An X-ray of the chest revealed parenchymatous deposits in both upper lobes, including apices. Enlarged nodes in the right hilus; calcified nodes in the left, supraclavicular region. The right pleura was thickened, diaphragm normal. Aorta was tortuous and sclerotic.

The shoulders were contracted against the chest-wall. Elbows were pathologically flexed and partly ankylosed. Wrists were boggy and swollen; phalanges were spindle-shaped, hyper-extended and relaxed. The knee-joints were globular, boggy and filled with fluid; patellæ float. The ankle-joints were swollen and rigid; feet were in equinus. (Fig. 4.) The spine was kyphotic and rigid. An X-ray of the knee-joints showed extensive destructive process with erosion of the articular surfaces, luxation of tibia,

outward. The spine showed marked atrophy of vertebral bodies; preservation of intervertebral spaces. Hip-joints showed absorption of articular surfaces. The skeleton showed marked atrophy.

Laboratory Examination.—Urine showed faint traces of albumen, occasional hyaline cast. Wassermann test, negative; blood chemistry, normal; synovial fluid from right knee, cloudy, yellow and turbid. Microscopical examination showed few epithelioid cells, fat globules, crystals resembling cholesterol and few lymphocytes. No acid-fast bacilli. *Lymph-nodes and spleen of inoculated guinea-pig, six weeks later, revealed acid-fast bacilli.*

The patient was transferred to the orthopædic service and resection of the right knee was done. Findings at operation were complete disintegration of the joint; thickened synovial membrane; flaky, yellow, fatty deposits lining the joint cavity; semilunar cartilages were completely destroyed; crucial ligaments preserved; tibia of dead-white

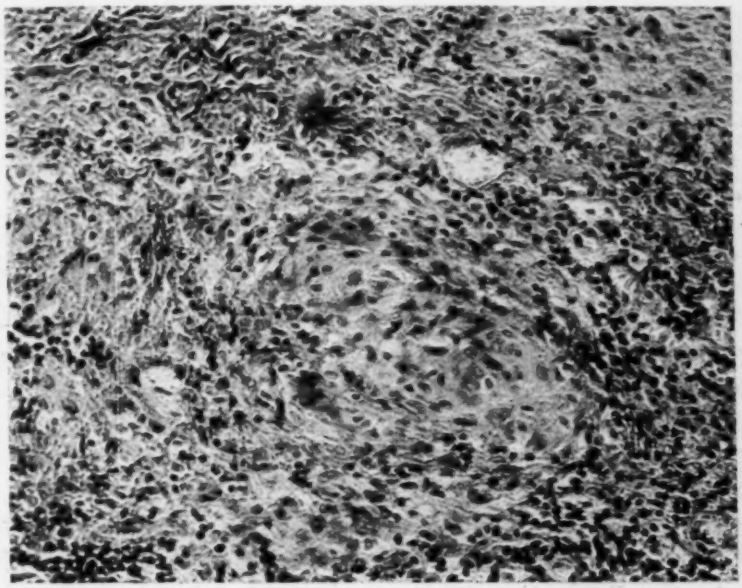

FIG. 5.—Tuberculous granulation tissue showing conglomerate tubercles.

appearance and was completely bloodless. The bone was sutured in the usual manner; case applied from ribs down to toes. This had to be removed at the end of two weeks as the patient objected. An abscess developed at the site of incision which exhibited typical characteristics of tuberculous pus. The patient was discharged March 29, 1931, in poor condition.

The histological report by Dr. Benjamin Gouley is as follows: The synovial membrane is greatly thickened by a hyaline fibrosis in which are scattered small foci of cells, often perivascular (around capillaries), consisting of round cells and a larger cell with eccentric nucleus, suggestive of a plasmocyte, except for its increased size and a slight tendency to acidophilic stain of the cytoplasm. (Fig. 5.) Two conglomerate tubercles are found which confirm the guinea-pig test.

This case was perhaps the most startling of the entire series. It represents that type spoken of by Barker as primary, progressive polyarthritis—the most malign of all arthropathies. Cecil and Archer, who reported on 612 cases of chronic arthritis, found eighteen belonging to this particular

type. In none of these were they able to find the underlying, etiological factor. It is highly probable that in this series no actual tissue studies or pig inoculations were performed. Had they done so they might also have found tubercle bacilli to be responsible for this condition.

Comment.—Among the predisposing causes of chronic, rheumatoid arthritis, heredity, bad environment, anatomical type of individual, over-fatigue, *etc.*, have all been emphasized as important factors. The disease occurs in thin, asthenic, young adults with the narrow, costal angle, cold, clammy extremities and lowered blood-pressure. May not all of these symptoms be manifestations of a submerged tuberculosis, acquired in childhood and brought to the surface in adults, by such exciting factors as exposure, mental stress, physical exertion, acute intercurrent diseases and the like? In these patients tubercle bacilli or virus, attenuated and weakened by long habitation in a resistant host, flare up, invade the blood-stream and localize in predisposed tissue, usually serous membrane, where chronic, proliferative processes are excited.

Very little attention has been focused upon the relationship between latent tuberculosis and chronic arthritis. A careful examination of all patients suffering from chronic arthritis, including X-ray of the chest, may reveal, in a certain percentage of these, healed, latent or active foci of tuberculosis in the parenchyma of the lung, peribronchial lymph-nodes or hilus region, but the significance of these findings as the cause of the arthritis is rarely, if at all, given credence.

In discussing this matter with a few clinicians I have been surprised with their views on the subject. They all seem to agree that the two diseases may co-exist in the same patient, but that they are unrelated and independent clinical entities.

Poncet and others maintained that articular inflammation is often the first evidence of metastatic invasion by toxin or bacilli from a distant, focal lesion of tuberculosis. The inflammatory changes in and around the joint are due, in a great majority of instances, to the virus; the synovial exudate does not contain tubercle bacilli, neither do they develop in the joint structures. Such a joint eventually may develop into a true tuberculous joint with bacilli, tubercles, giant cells, *etc.* The pathological process may be acute, subacute or chronic; one joint may suffer or a number of joints may be simultaneously involved.

The disease is most apt to arise after operation on tuberculous glands or bone, or it may develop in the course of any acute intercurrent infection (influenza, pneumonia, *etc.*). The articular lesions do not show the specific picture of giant cells and tubercles; the histological picture cannot be distinguished from that of ordinary inflammation, yet these lesions can often be proven by experimentation to be tuberculous.

MacCallum states that the occurrence of inflammatory reaction, caused by avirulent strains of tubercle bacilli or virus, resembles rather closely that

which follows the invasion by non-pyogenic coccal infections. It is a process entirely different from that found in the specific picture of tuberculosis.

Calmette and Valtis, in a recent contribution on "Filterable Elements of Tuberculosis Virus," maintain that the disease called tuberculosis and characterized by the presence of giant cells containing bacilli and of tubercles in various organs, is only the chronic form or end stage of an infection caused by an ultra virus, whose elements are at first invisible but gradually become non-acid fast, dust-like bodies and, if circumstances are favorable for their growth, later develop into tubercle bacilli. Serious effusions into the pleural, pericardial, peritoneal and synovial cavities appear to be caused by the ultravirus exclusively. In many of these cases it is extremely difficult to find acid-fast tubercle bacilli.

In discussing inflammatory tuberculosis, MacCallum makes this highly significant assertion: It occurs in individuals who have had an old focus of disease and who may therefore be thought of as hypersensitive or immunized. The inflammation may be inconspicuous if the dosage be small. Showers of bacilli in great numbers cause the most profound intoxication, and set up destructive processes everywhere. In persons whose resistance to tuberculosis is high the reaction of the joints to the infection, or toxemia, may be mild and pursue a subacute or chronic course. Such reactions simulate the effect of the occasional intermittent escape of non-pyogenic streptococci, gonococci, staphylococci and the like. In the involved joints abundant vascularization appears on the free surfaces with thickening of the synovial membrane, villous hypertrophy and the formation of pannus or granulation tissue over the articular cartilages. This granulation tissue bears a striking resemblance to that produced by other infections; it may exhibit distinctions which may be recognized histologically. It is perhaps more thickly infiltrated with large and small mononuclear cells and contains few polymorphonuclear cells. In the advanced stage it is distinguished by its high content of scattered epithelioid and giant cells.

In our series of cases the characteristic features were the preponderance of endothelial cells and œdematous infiltration. The latter was almost mucoid or gelatinous. In some of these cases the large cells had eccentric nuclei and took the acidophilic stain. The cell infiltration was diffuse throughout all the sections examined and in some there was also perivascular infiltration. Some sections showed marked narrowing of the lumen of small arteries, due to spongy swelling of the intima. This non-infectious arteritis is seen in the neighborhood of tuberculous lesions and may be termed "contact arteritis." In addition to these findings tubercle formation and caseation were present, making the diagnosis obvious.

A few remarks regarding diagnosis of chronic, tuberculous polyarthritis are germane, and in this connection I wish to emphasize the importance of biopsy and guinea-pig inoculation in definitely establishing the identity in these cases.

In an article by Allen deForest Smith he states that a positive diagnosis

cannot be made by the ordinary methods so far in use. He pointed out that many cases of tuberculosis are commonly mistaken for chronic arthritis and synovitis, and reversely.

Allison and others affirm that the only positive proofs of tuberculosis are the pig tests, specific findings and the microscopic discovery of tubercle bacilli in the pus or tissues.

In view of the importance of this subject it is my firm belief that many cases masquerading as arthritis deformans, atrophic arthritis, rheumatoid arthritis, *etc.*, are really tuberculous processes. Our suspicions as to the tuberculous nature of these joints should be aroused if the history points toward a tuberculous background and the physical and X-ray examinations of the chest reveal tuberculous pathology. The X-ray examinations are practically of little value in the diagnosis, as are the Von Pirquet and Mantou skin tests.

In cases of chronic arthritis and other forms of systemic tuberculosis Reitter and Lowenstein have recently been able to isolate from the blood-stream the tubercle bacilli, by means of a special culture media. This will prove to be a distinct advance if confirmed by other observers. Until then, sole reliance must be placed upon tissue study and it is urged that more patients suffering from chronic arthritis be subjected to arthrotomies for the purpose of clearing up the diagnosis.

CONCLUSIONS

I fully realize the limitations of this contribution which is based upon such a small group of cases of proven tuberculous polyarthritis. Nevertheless, these cases are probably representative of a great many others labeled as arthritis deformans, chronic infectious arthritis, *etc.* I have endeavored to show that chronic, tuberculous polyarthritis exhibits the clinical picture resembling the ordinary forms of so-called rheumatoid arthritis. It is hoped that this communication will stimulate interest in the subject so as to clear up the etiology of a condition which in the past has been so baffling.

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KRUKENBERG TUMOR OF THE OVARY

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Frederick Krukenberg,[1] in 1896, described a peculiar malignant tumor of the ovary to which he gave the term *fibrosarcoma mucocellulare carcinomatodes*. As the name implies, Krukenberg considered the tumor to be primarily a fibrosarcoma with elements in its structure resembling carcinoma. He described it as a solid ovarian tumor, usually bilateral, maintaining the form of the ovary, of myxomatous appearance, occurring in young and old subjects, growing slowly, usually with ascites, and eventually fatal by extension or recurrence. He described the structure as presenting small groups or a diffuse growth of large polyhydral or rounded cells with mucoid contents compressing the nucleus into a signet-ring form. He believed the tumor to be primary in the ovary.

Since the original description of Krukenberg, R. H. Major[2] has made perhaps the most noteworthy contribution to our knowledge of this tumor. He collected and studied fifty-five authentic cases and concluded that, histologically, the tumor is essentially a carcinoma containing elements of fibrosarcoma, that it is usually secondary to carcinoma elsewhere, especially to that of the stomach or intestines.

Ewing[3] is inclined to believe that the pure Krukenberg tumor is always secondary, and that primary carcinoma presenting this structure regularly yields other areas of a different type of carcinoma.

In 1929, Fallas[4] was able to collect twenty-three additional cases. A repetition of his summary regarding our knowledge of these tumors may help in a clearer understanding of the two cases to be reported. His conclusions were as follows:

(1) Krukenberg tumors are essentially a form of carcinoma identified by large mucinous cells often with eccentrically placed nuclei.

(2) They are almost, if not quite, invariably secondary to carcinoma elsewhere and usually to that in the gastro-intestinal tract.

(3) They metastasize early and are almost invariably fatal.

(4) They grow in a way to produce a general enlargement of the ovary which keeps its general form and is usually free of adhesions.

(5) Ascites is usually associated with the tumor.

In 1930, Enzer[5] reported a case in a married woman, aged thirty-six, with bilateral ovarian tumors floating free in the abdominal cavity in a moderate quantity of clear ascetic fluid. A hard, indurated area was palpable in the stomach. The author brought the reported cases up to date, making a total of eighty-five.

In the same year, Tyner[6] reported the case of a married woman, aged forty-eight, in whom the right ovary was involved with Krukenberg tumor and the left ovary was normal. The greater curvature of the stomach was the seat of an extensive carcinoma, and a gallon of clear ascitic fluid was present in the abdominal cavity.

Also, in 1930, Jackson and Babcock[7] reported a case in a married colored woman, aged fifty. There was bloody fluid in the abdominal cavity with a markedly contracted

stomach containing a carcinoma of the Krukenberg type. Similar tumors were present in the left ovary and in the right mammary gland; the latter was large and discommoding and was the reason for which the patient sought surgical relief.

I have seen two cases of this condition. For the privilege of reporting the first case I am indebted to Dr. L. I. Breitstein and Dr. J. Schwarz, of San Francisco.

CASE I.—Mrs. R. F., multipara, aged thirty-four, was seen on July 29, 1922, complaining of pain in the lower abdomen and frequency of urination. The patient had lost forty pounds in the past three years and abdominal pain, chiefly over McBurney's point, had been present for the past six months.

Physical Examination revealed an abdominal tumor extending about eight centimetres above the symphysis; the mass was hard, somewhat irregular, and tender. Vaginally, the mass encroached on the vagina, filling the superior strait. The tumor resembled a fibroid of the uterus, and that was the pre-operative diagnosis.

Operation was performed on August 3, 1922. A moderate quantity of free ascitic fluid was present. The uterus was small and appeared normal. Tumors of both ovaries were found, the right ovarian mass was twisted on its pedicle, and was incarcerated in the pelvis. It was not adherent, was globular in shape, and measured about twelve by ten centimetres. The tumor of the left ovary was warty and hard, egg-shaped, and measured ten by eight centimetres. A bilateral oöphorectomy was performed. Examination of the gall-bladder and stomach was negative. Grossly the appendix seemed to be the seat of a malignant process and was not disturbed. Pathologic examination was made by Dr. G. Y. Rusk, of the University of California, San Francisco. Examination of the ovarian tumors revealed an essentially solid tissue type of growth with a honeycomb appearance on cross section. The microscopic sections showed the characteristic picture of Krukenberg tumor.

After consultation with the pathologist and röntgenologist, it was concluded that the appendix was the primary source of the malignancy and that it should be removed.

On August 16, 1922, the appendix, measuring 9.5 centimetres by 2.2 centimetres, was removed through a McBurney incision. It was grayish pink in color, with a firm and rather elastic consistency, and was bent at an acute angle near the middle. No definite lumen could be demonstrated on cross section. Microscopic examination revealed large, faintly staining, rounded cells with eccentrically placed nuclei; many of the cells had the signet-ring appearance. These cells were present in spaces encapsulated by loose strands of connective tissue and muscle.

The patient died two days following the second operation. The immediate cause of death was attributed to a rather advanced myocardial degeneration. Necropsy was not obtained.

CASE II.—The second patient, Mrs. I. J., Norwegian by birth, aged forty-five, had consulted Dr. Harold Brunn, of San Francisco, in September, 1915. At that time the patient was thirty years of age. She complained of nervousness and irregular menses. Physical examination was negative except for a moderately enlarged thyroid with a suspicion of exophthalmos and a secondary anæmia. The uterus was in second-degree retroflexion. The patient was given Blaud's pills and ovarian extract, with resulting improvement.

She was not seen again until March, 1930. At this time her chief complaint was gas distress after eating, dating back to 1917. X-ray examinations made in 1917 revealed ptosis of the stomach for which the patient was treated, with resulting improvement. She had not been well for the past year and believed that her abdomen was growing larger but thought she had lost no weight. Her periods were regular, from three to four days in duration, but the flow was scanty. One sister had had a tumor of the stomach and another had a fibroid of the uterus.

FIG. 1.—Anterior view of the large ovarian tumors attached to the uterus; the latter contains two small subserous fibroids in the region of the fundus. The insert shows the appearance of the ovarian tumor in cross section.

Physical Examination.—Blood-pressure 124/80. The patient was fairly well nourished and essentially normal except for her abdomen. A hard, nodular, movable tumor occupied most of the abdomen below the umbilicus. Considerable free fluid was present in the abdominal cavity. Vaginal examination revealed the tumor growth anterior to the uterus and probably not attached to it. The abdomen was opened on March 14, 1930. About three and a half liters of clear free fluid were present in the peritoneal cavity. The mass felt through the abdominal wall (Fig. 1) proved to be bilateral, solid ovarian tumors. They were not adherent and had not broken through the outer capsule of what once had been the ovary. No metastases were present in the gall-bladder, liver, or peritoneum except for a small nodule in the uterovesicle fold. The stomach was not palpated as we were unaware at the time that we were dealing with a Krukenberg tumor. The uterus contained several small fibroids. Bilateral salpingo-oöphorectomy, supravaginal hysterectomy, and appendectomy were done.

Microscopic examination by Doctor Rusk of sections from both ovarian tumor masses showed an invading new growth of abnormal epithelium growing in fine strands and clusters. In portions of the growth the epithelial cells occurred singly; these were

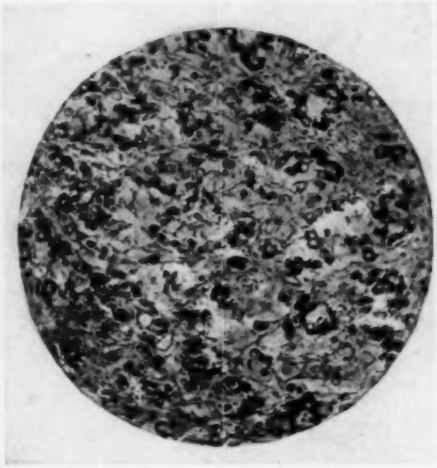

FIG. 2.—Low-power photomicrograph revealing the cells which typify the Krukenberg tumor.

FIG. 3.—High power of Fig. 2. Several signet-ring cells appear in the field.

swollen, each contained a large droplet of mucus and gave the typical appearance of the Krukenberg tumor. (Figs. 2 and 3). Cells in mitotic division were rare. The uterine tumors were myomata. The nodule removed from the parietal peritoneum near the uterovesicle fold was found to be the seat of a moderate invasion with adeno-carcinomatous elements similar in character to those found in the ovary. The appendix was essentially negative.

During convalescence, the patient's stomach was investigated. There was no free hydrochloric acid and X-ray examination revealed a polypoid type of lesion in the greater curvature of the cardiac end of the stomach.

The patient did fairly well after operation but had several tarry stools; these continued after her discharge from the hospital and occasionally she vomited blood. Rather severe gastric hæmorrhages began about November 1, 1930, and continued until the patient's death on November 20. Necropsy was not permitted.

SUMMARY

(1) Two cases of Krukenberg tumor of the ovary are reported. These cases bear out the conception of the more recent writers that Krukenberg

tumors of the ovary are nearly always, if not invariably, secondary to carcinoma elsewhere and usually to that in the gastro-intestinal tract.

(2) In the first case, the growth was most likely primary in the appendix, but this cannot be determined definitely as there was no post-mortem. In the second case, the growth was in all likelihood primary in the stomach, but in this case also necropsy was not allowed.

(3) The total number of reported authentic cases is brought up to date, giving a total of eighty-nine including the two cases appearing in this communication.

(4) It is felt that if the summary of our knowledge of these tumors as outlined by Fallas is borne in mind, more of these growths will be recognized and diagnosed pre-operatively.

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TREATMENT OF POTT'S FRACTURE

REPORT BASED ON FIFTY CASES

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The function of the ankle-joint, generally speaking, may be divided into two actions: a static, which maintains the posture and carries the weight of the body, and a dynamic, which institutes propulsion and regulates progression in the act of locomotion. These functions are made possible by the singular anatomical arrangement of the bones entering into the formation of this joint; the astragalus and lower ends of the tibia and fibula, creating a mortise, a relationship found nowhere else in the body, which allows the entire body to pivot on the astragalus as a fulcrum. Any injury which deranges this well-fitting mortise, disturbs the smoothly working pivotal action, producing a gyrating effect, with imbalance and falling. Further, the ankle-joint may be regarded as one of a pair of bases in the arch, in which the pelvis is the keystone, and the lower extremities are the abutments. Thus the whole weight of the body is equally divided and transmitted along the carrying angles of the lower extremities to be distributed *via* the ankles on to the feet. It is not surprising, then, to find that bony injury to so highly specialized a joint creates a disability which is immediate, complete, and compelling.

Besides this bony framework, the surrounding soft parts, synovial membrane, ligaments, tendons, cartilage, vascular and neural structures, and integument, the latter in close association with the bony landmarks, share in the injury, producing the arthro-teno-synovitis, that often requires more after-care than the actual fracture itself. The intimate contact of bone and skin in this region, with injury or irritation to the cutaneous nerves at the time of fracture of the bones, may explain the not uncommon associated large bleb formation in a badly comminuted fracture of the ankle or lower leg without contusion of the skin. Because of its architecture, fractures of this joint share with all intra-articular fractures in the possibility of being the most crippling, the most productive of deformity, and the most likely to leave a permanent disability.

It follows, therefore, that a complete functional restoration following an injury, such as Pott's fracture, in which the relationship of the bones of the ankle-joint is deranged, can only be brought about by perfect realignment of the anatomical landmarks of the joint structure. This is best accomplished by an early reduction. For an early reduction means an easy and good reduction, and a good reduction implies correct coaptation of fragments, which leads to good bony repair with minimal callus, precluding the

possibility of bony joint blockage due to irregular or exuberant callous formation. Repair here conforms to the axiomatic dictum that bony union invariably takes place in fractures within or near a joint, with the exception of fractures of the neck of the femur. But it also corroborates the well-known clinical experience that cartilage heals poorly and irregularly, so that injury to this tissue in association with bony injury may present the picture of dysfunction in spite of perfect reduction and alignment. This sequence of injury, recognition, reduction, retention, repair, and restoration of function operative here, as well as in all fractures, is the basis of our treatment.

In the present paper, an analysis of fifty consecutive, unselected cases of Pott's fracture is presented as a qualitative, rather than a numerical or quantitative study, because it is the writer's belief that a report of cases where personal contact is present in each case throughout the entire period of uniform treatment is more fertile in observations and experiences, and therefore more fruitful in conclusions, than a large number of cases under diversified management and treatment.

To obviate controversy, let it be understood from the outset, that, herein, a Pott's fracture will be regarded as one in which there is a fracture of the lower end of the fibula, associated with a tear of the internal lateral ligament or an avulsion of the tip or the entire internal malleolus with or without a lateral or posterior dislocation of the foot. This picture is often accompanied by a fracture of the medial or interosseous malleolus of the tibia, which may be missed upon the X-ray, unless trained to look for it; and requiring an oblique X-ray exposure of the ankle for demonstration. When present, this additional fragment of bone may act as a bony block in reduction, or interfere with maintenance of reduction, necessitating its removal A modification of this, consisting in the splitting away of a wedge of bone from the posterior lip of the tibia, may act in a similar manner and require similar attention. Let it also be understood that treatment here, as in all fractures, is accorded upon a basis of typing fractures, into type I and type II. Type I comprising the displaced fractures, requiring reduction, and type II, the non-displaced fractures not requiring reduction. In both types, preliminary first aid in the form of a pillow splint or padded wooden splints applied from the knee to and including the foot, is given to put the broken parts at rest preventing increase of deformity and compounding. Compounding in a Pott's fracture often implies direct violence as the causative trauma, instead of the usual indirect violence responsible of the simple variety of this fracture. This situation, when present, is coped with in the early (six hours), or pre-incubation period of the contaminated organisms by mechanical sterilization which aims to expose the fracture site to vision, and excise all damaged and devitalized tissues, followed by primary suture with drainage. The safest procedure in converting a compound into a simple fracture, when seen later than six hours, is to resort to primo-secondary or delayed suture in which all steps except suture are taken, and the actual suturing is performed after the third day, when we are assured clinically

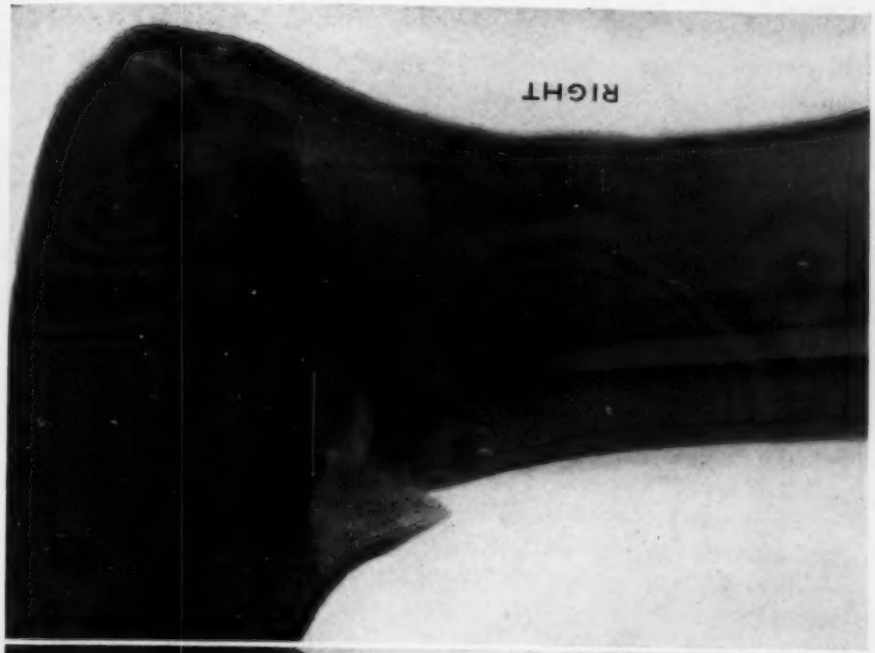

FIG. 1.—Lateral view showing posterior dislocation of foot.

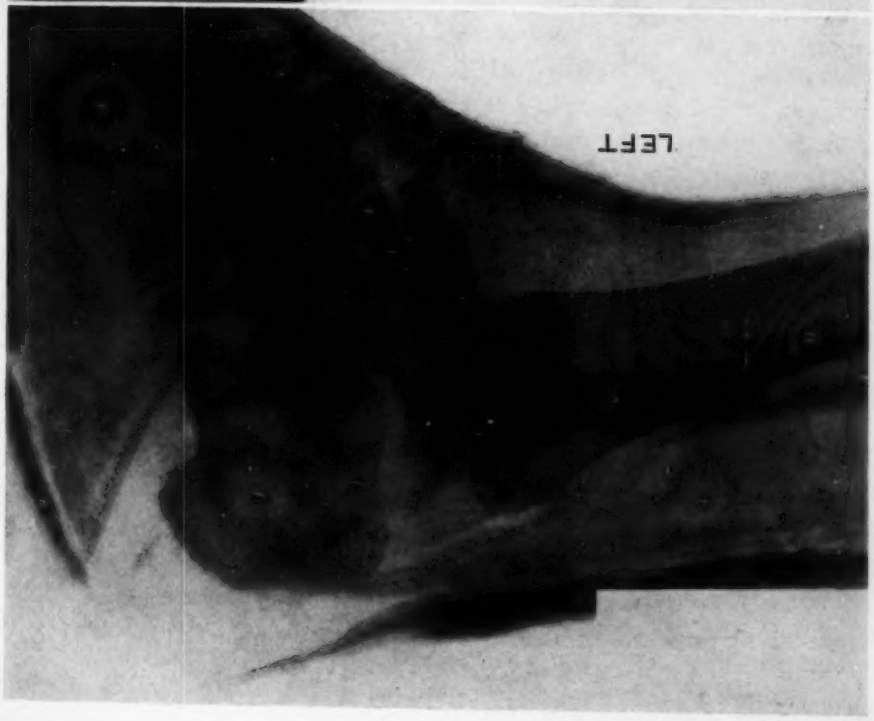

FIG. 2.—Pott's fracture. Lateral view, showing anterior dislocation of foot. Ineffectual attempt at manual reduction.

and bacteriologically of the asepsis of the wound. An already infected fracture is a problem in osteomyelitis, and treated as such.

Inasmuch as, in the treatment of a displaced or type I fracture, we aim to convert it into a non-displaced or type II fracture by reduction, and thence the treatment is identical in both, a standardized form of treatment of the former variety of Pott's fracture will be described.

Reduction.—Manual reduction is carried out under anæsthesia, either general or spinal, to insure complete relaxation. For displacement of fragments is maintained and increased by muscular spasm, so that we really "set" a fracture by "setting" the muscles, in overcoming muscular spasm. With the thigh hyperflexed and the knee bent, to relax the calf group of muscles, an assistant "crooks" his elbow in the popliteal space pulling toward the head of the patient, as counter-traction. Where an assistant is not available, a muslin bandage or folded sheet, passed over a cotton pad in the popliteal space and tied to a fixed object at the head of the table, will suffice. The operator then grasps the heel and instep, applying slow and steady traction until a sense of "giving" is felt, then with the traction maintained, the foot is flexed (pushed upward) and inverted (pushed inward). This overcomes the backward and outward displacement and reëstablishes the normal relationship of the mortise. The deformity has now been overcome and this corrected position is maintained by the assistant gently pulling toward the head of the table on a bandage tied to the great toe, while the knee is straightened, and until immobilization has been effected. Where force is needed to retain the foot at right-angled inversion, we may be reasonably sure that correction is incomplete, and that an everted foot will be the result. When the fragments are impacted, the ankle is manipulated in all directions until free crepitus or false motion is noted. This unlocks the fragments and of itself may effect reduction. In some cases an Achilles tenotomy is necessary to completely reduce the deformity. When reduction is contra-indicated because of the physique of the patient, or the application of splints is inadvisable because of the presence of infected blebs, skin-traction and suspension may be applied with knee bent, and foot dorsi-flexed and inverted, and the treatment carried along in this position.

Proofs of effected reduction are: (1) Restoration of relation of bony landmarks. Reëstablishment of mortise. (2) Pressure on the sole of the foot by one finger keeps the ankle at right angles. (Jones's Test.) (3) Pressure upward on the sole of the foot does not reproduce deformity. (4) Reëstablishment of the normal-carrying angles as manifested by the co-relation of the lower end of the tibia and upper surface of the astragalus, so that a line dropped down the middle of the front or side of the tibia, bisects the astragalus. This assures the normal pivotal action of the leg upon the astragalus, and *vice versa.*

Retention or immobilization is now instituted with the foot in right-angled inversion by means of plaster-of-Paris moulded splints of the Stimson variety, consisting of a posterior and internal lateral part, running from just

below the knee to and including the foot. After-care aims at an early restoration of articular activity. We know that in intra-articular fractures with hæmorrhage into the joint, fibrinous adhesions are formed, which at length become fibrous; and intra-articular fibrous bands may lead to bony ankylosis. Guarded early passive motion (after ten days) with guarded active motion soon to follow, causes the blood to be absorbed quickly and keeps the joint in a supple condition. To this end moulded plaster-of-Paris splints give access to both visual and tactile inspection of the injured parts, and to early application of massage. Part of the splint, the lateral, is removed when union is firm, at the end of twenty days, and the posterior splint is removed when union is solid and X-ray reveals callous formation, thirty to forty days. Walking about on crutches, but no weight-bearing, is allowed after one week.

In type II cases where reduction was early and the intra- and peri-articular damage is minimal, as estimated by the amount of swelling and X-ray findings, the patient is allowed up, in a plaster encasement with a walking iron attachment, after the acute or inflammatory stage subsides, when swelling has considerably or completely disappeared. Standing and walking with weight-bearing are permitted when pushing the foot hard against the floor produces no local reaction in terms of pain, swelling, or redness; and flat-foot precautions are instituted for a time by advising walking on the outer side of the foot with the toes in, and building up the inner side of the heel half an inch.

In fractures seen late with mal-union, open reduction is indicated.

STATISTICS

1. Males	36 cases	36 cases
Females	14 cases	14 cases
2. Age incidence		
Oldest case		70 years
Youngest case		19 years
3. Direct violence		23 cases
Indirect violence		27 cases
4. Right side involved		29 times
Right side involved		21 times
5. Displaced or type I cases		12 cases
Non-displaced or type II cases		38 cases
6. Compound fractures		3 cases
7. Associated lesions		
Fractured ribs		4 times
Colles' fracture		1 time
Skull fracture		1 time
8. Duration on admission		
Shortest time		1 hour
Longest time		2 weeks

TREATMENT

Non-operative

9. Moulded plaster-of-Paris splints		48 times
Plaster-of-Paris circular bandage		2 times

Operative

10. Immediate débridement	1 case
Skeletal traction	1 case
Open reduction	1 case
11. Duration of splintage	
Shortest time	21 days
Longest time	60 days
Average time	35 days
12. Time in bed	
Shortest time	1 day
Longest time	56 days
Average time	17 days
13. Time in hospital	
Shortest time	3 days
Longest time	60 days
Average time	21 days
14. Duration of physical therapy treatment	
Shortest time	4 weeks
Longest time	32 weeks
Average time	10 weeks
15. Total duration of treatment	
Shortest time	6 weeks
Longest time	40 weeks
Average time	10 weeks
16. Complications, osteomyelitis	1

In arriving at a functional result in Pott's fracture, the static and dynamic actions of the joint loom as the keynote in the desired triad in end-results, *viz.*, function, union, and contour. These are named in the order of their importance, and hence in the sequence of their desirability. Function or the capacity to perform being the most important, and here measured in terms of standing, and walking without pain or limping, is allotted a trifold numerical value, as compared to union and contour. Union or the state of repair, measured in terms of consistency, amount and distribution of callus, shares equally with contour and appearance, measured in terms of deformity, swelling and pes planus. This numerical ratio and mathematical grading of 60 per cent. for function, and 20 per cent. each for union and contour, though arbitrary, gives a uniform and standard valuation of end-results which, to our mind, is more satisfactory in producing a fixed basis of comparison, than the elastic terms of fair, good or perfect. End-results were obtained in twenty-three cases in this series, most of which were graded by at least two men and often three or more, and the average allotted to the individual case. No case was considered an end-result, any earlier than six months, this being considered sufficient time for a complete restoration of function, and is about twice the duration of the average total treatment. In this group there were seven females and sixteen males with four of the displaced or type I variety; and nineteen of the non-displaced or type II variety.

The average total for all the follow-up cases was 77 per cent.; divided into 47 per cent. for function, 16 per cent. for union and 14 per cent. for contour. The highest aggregate was 98 per cent.; divided into 60 per cent.

for function, 20 per cent. for union and 18 per cent. for contour. The lowest aggregate was 55 per cent.; divided into 30 per cent. for function, 14 per cent. for union and 11 per cent. for contour.

CONCLUSIONS

(1) This series would indicate that Pott's fracture is essentially an injury of adult life. The forces active in producing a Pott's fracture in an adult will produce an epiphyseal separation of the lower end of the tibia in a child.

(2) Judged by this series the ratio of incidence among males and females is approximately three to one.

(3) The automobile and modern industry as factors in injury are gaining in placing direct violence as a cause of this fracture, where indirect violence used to predominate.

(4) Displaced or type I fractures, in this region, require meticulous reduction and alignment to restore the highly specialized action of this joint, and prevent dysfunction that may follow poorly or irregularly healing cartilage, as a result of incorrect coaptation.

(5) Compounding with infection in the shaft of the bone is a regrettable occurrence; in a joint fracture it may become a tragedy. Hence, the importance of immediate attention. The ability to arrest infection being in indirect proportion to the duration of contamination.

(6) Where maintenance of reduction is a difficulty, one should be on the outlook for a fracture of the medial or interosseous malleolus of the tibia, or a tearing away of the posterior lip of this bone.

(7) The use of skeletal traction may then be necessary, and for that purpose a Kirschner pin or Steinman nail through the os calcis with or without a preliminary Achilles tenotomy are excellent adjuvants in the treatment of this complication. Where this fails, operative removal of the fragment is the choice.

(8) The use of moulded plaster-of-Paris splints instead of a circular encasement is a distinct advantage in the treatment of a Pott's fracture. It permits visual and tactile inspection of the fracture site, and promotes early passive activity.

(9) Physical therapy is an integral part of this treatment, and should be concomitant with, rather than subsequent to, immobilization. For a joint is as strong as its component muscles and tendons that mobilize it, and early restoration of muscle and tendon activity means lessened incapacity of the joint.

(10) Function may be consistent with deformity in a shaft fracture, but is decidedly inconsistent with a joint fracture.

(11) Old fractures of the ankle with malunion and ankylosis are a problem in joint plastics, requiring open correction and may prove disappointing.

(12) Non-union here is a rarity. When it does occur it speaks for interposition of soft parts, tendon, fascia or curled periosteum.

(13) Often under the best conditions, with the best of care, in frankly displaced or type I fractures, swelling and pain in the ankle will persist for a long time, as well as a widening of the joint, due to a tear of the lower tibio-fibular ligament.

(14) All the above statements would indicate that the treatment of Pott's fracture is by no means a closed chapter and that poor results will follow even in the hands of those specially trained to deal with these injuries.

(15) This series is presented as an attempt at standardization of fractures along the path of uniformity of classification (nomenclature), treatment (management), and grading (evaluation of end-results).

PROGRESSIVE POST-OPERATIVE CUTANEOUS GANGRENE

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In 1924, Cullen reported a case which presented a very extraordinary type of cutaneous gangrene,[7] appearing in an incision made to drain an appendiceal abscess. His report was illustrated with water-color plates, and the condition was obviously—both in appearance and in its course—very different from any of the usual types of post-operative wound infection. Other men began to report similar experiences, most of the cases occurring in drained appendicectomy incisions—but the total number of reported cases has remained small (approximately twenty), and one is justified in assuming that the condition is rare. While it is true that many cases have probably been observed and not reported, the comments of experienced consultants in regard to Cullen's case[7] certainly support the belief that this type of complication is infrequently encountered.

Various terminologies have been used in attempting to apply an appropriate descriptive name to the condition, but a review of the reported cases leaves the very definite impression that all represent exactly the same process, probably due to the same etiological agencies, and form a definite clinical entity. Lynn recently expressed this opinion in a paper presented at the meeting of the American Medical Association, in Philadelphia.[11]

In May, 1926, Dr. George Brewer read a report of two such cases before the American Surgical Association, in Detroit, and he subsequently reported[3] elaborate bacteriological studies carried on by Meleney in an attempt to throw light on the etiology of this extraordinary complication. Meleney advanced the theory that the process was due to a sort of symbiosis indulged in by a certain strain of streptococcus and a staphylococcus, the former preferring little oxygen for its growth, and occurring in pure culture in the inflammatory zone beyond the margin of the advancing slough. The impression was based on animal experiments in addition to the clinical findings. More recently, Meleney has amply confirmed his earlier ideas in regard to this symbiosis of the strains involved—through additional clinical and experimental studies—and has presented his findings in more detail, along with a general discussion of bacterial synergism.[13]

Doctor Meleney was good enough to examine the patient that forms the basis of this report, and assures me that the clinical and bacteriological findings fall exactly in line with those of his own cases. It has seemed therefore appropriate to add another case report to the growing list.

Case Report.—B. J., age sixty-two, was admitted to the Roosevelt Hospital June 29, 1930, complaining of abdominal pain of eighteen hours' duration. History and physical examination were quite typical of a fulminating acute appendicitis. Immediate operation

revealed an acutely inflamed appendix, with perforation at the base, and a rather extensive diffusing peritonitis. Following appendicectomy with drainage his recovery was uneventful. The temperature reached normal on the sixth post-operative day, and remained so until his discharge, except for one reading of 100.4°. He was allowed home on the twenty-fourth day after operation with the wound entirely healed.

Following his return home he felt unusually well for two months, at which time he began to have a persistent hacking cough, which troubled him a great deal at night—and which shortly thereafter became productive, the sputum resembling thick tomato soup. For the next seven months his cough continued much the same. There was no loss of weight or strength, and no night sweats or fever. He remained at his work, and felt quite well apart from this annoying cough. During this time he was treated as an ambulatory case, and prolonged and various efforts were made to identify the pathology underlying the cough. Repeated blood Wassermann examinations were negative. No tubercle bacilli were found in the sputum. The sputum was centrifuged and sectioned, nothing being found in it to suggest neoplasm. Blood pressure was 168/78. The heart seemed slightly enlarged. Physical examination of the lungs revealed flatness at the right base below the angle of the scapula, with absent breath sounds. The physical findings over the remainder of the lung fields were normal.

Examination of the upper abdomen revealed no abnormal findings. X-ray examination showed a rounded shadow at the right base. It was difficult to be sure whether this was above or below the diaphragm, its outline being smooth and rounded. Bronchoscopy showed bloody sputum coming from a bronchus distributing to the right lower lobe posteriorly. Lipiodol instillation did not add any information. Further fluoroscopical studies increased the doubts as to the nature and location of the rounded shadow. Neoplasm was the favored diagnosis. Exploratory aspiration was done by Dr. Victor Lyman, and blood-stained pus was obtained from above the diaphragm—the material being quite similar to the sputum that the patient had been raising for so long. Culture showed a very small streptococcus that grew poorly in aërobic cultures. It grew better in sub-cultures, forming fairly long chains. No other organisms were found. The patient was referred for thoracotomy.

On April 1, 1931, two inches of the right tenth rib were removed under local anæsthesia, exposing a well-localized empyema cavity the size of a hen's egg, filled with the same "tomato soup" material that had been aspirated. A careful search revealed no evidence of the expected communication with a bronchiole. The small cavity was packed open, and one silkworm-gut suture was placed at the anterior angle of the incision. Following exposure and emptying of the cavity, no more sputum was raised, and the cough was immediately relieved. He was allowed to go home on the eleventh post-operative day, temperature having been normal for one week, and the wound being nearly healed.

Twenty-two days after the thoracotomy the patient was readmitted to the hospital on account of a slowly but surely progressing infection of the chest wall. This had first appeared in one of the silkworm-gut stitch-holes as a small furuncle-like spot. It enlarged slowly, progressing downward and forward, and never crossing the old incision, which had now healed. The patient felt well, temperature was normal, and he did not complain of pain unless disturbed. The involved area was, however, excruciatingly tender to the touch—a very striking feature. The advancing edge of the process was preceded by a wide, bluish, inflammatory zone. As this advanced, it left behind a tenacious gray slough resembling dirty felt. From beneath this many small beads of pus appeared on slight pressure. The slough involved only the skin and subcutaneous tissue, and the central part of the lesion, where the sloughing process was complete, presented a clean granulating surface. (Fig. 1.) Cultures from the sloughing area now yielded a hemolyzing staphylococcus, in addition to the very small micro-aërophilic streptococcus—apparently the same organism as that found in the material aspirated from the chest before operation.

Various local treatments were of absolutely no use in halting the progress of the lesion. Removal of slough and local incisions (nitrous-oxide anæsthesia) did not improve matters. Hot poultices, Carrel-Dakin treatment, dilute iodine, dilute acetic acid, and even dilute formalin were tried without avail. The urine and the blood-sugar were normal. Blood Wassermann was negative.

On May 4, 1931, the margin of the large ulcerated area was excised with the actual cautery, under general anæsthesia. The excision was not carried outside the zone of redness, and there was a prompt recurrence of the process at two points in the periphery. Six days after the first excision, these two areas were excised widely. The condition gave us no further anxiety. Pain, redness, and tenderness did not recur. Thiersch grafts were applied to the granulating surface, and the entire area promptly epithelialized—with the aid of a small bud of epithelium that appeared unexpectedly in the middle of the granulating area—having survived the destructive process, probably in a deeply situated sweat-gland. The patient has since been symptom-free.

FIG. 1.—Showing the healed thoracotomy incision above and to the left. The central area presents a clean granulating surface.

Discussion.—The sequence of events in this case caused much speculation. It is probable that a pulmonary infarct was present when the patient left the hospital after the appendicectomy. Just why it should give no symptoms for months is difficult to understand. The infarct at the periphery of the right lung base finally broke down, and began to discharge through a small bronchus. The streptococcus was probably of intestinal origin. The area of the infarct became adherent to the parietal pleura and eventually formed, in effect, a small encapsulated empyema. Following drainage a local infection began in a stitch wound, and a cutaneous or air-borne staphylococcus joined with the streptococcus in producing the slowly progressing alarming gangrene that has been described above. Thus (as in most of these cases) the infection was of intestinal origin, although finally making its appearance in a thoracotomy wound.

The bacteriological findings corresponded to those of Meleney. A staphylococcus was found in association with an extremely small streptococcus, which grew poorly in aërobic cultures. In sub-cultures growth became more abundant. In the tissue excised at operation, the streptococcus was found in the outer zones where the lesion was extending, the staphylococcus being prominent in the areas where actual necrosis was present. On account of its preference for a low oxygen tension this particular strain of streptococcus belongs in the "micro-aërophilic" group. According to Meleney,[13] it is probably correctly referred to as "streptococcus evolutus." The difficulty encountered in growing it probably accounts for the fact that it has not been demonstrated in some of the reported cases.

In Meleney's first cases[3] a diphtheroid bacillus was found in addition to the two above-mentioned organisms. Subsequent clinical and experimental studies seem to indicate that this was an incidental finding. However, Mayeda[12] found somewhat similar organisms in his case, reported from the University Hospital in Tokio. It might be mentioned also that Homans' description[9] of the appearance and behavior of the lesion in certain cases of "wound diphtheria" corresponds almost exactly to the clinical findings in these cases. Cole and Heideman[6] demonstrated amœbæ both in smears and in sections from one of their cases of post-operative gangrene of the abdominal wall, but these findings have not been confirmed in subsequent cases in which they have been carefully sought for, and it is probable that the amœbæ were not the inciting cause of the process, but secondary invaders. The rare complication of gas-bacillus infection of the abdominal wall runs a rapid, extremely acute and characteristic course, and cannot be confused with the type of case we are discussing.[4,15] In a great majority of the cases a streptococcus has been the prominent factor in the etiological study, and the micro-aërophilic character was striking in the cases of Christopher[5] and Meleney[13] and in our own case. It is probably true that this characteristic clinical entity results from the activity of a streptococcus of intestinal origin, the gangrenous process resulting from a symbiosis with a staphylococcus, either air-borne or of cutaneous origin.

In its clinical aspects, as well as bacteriologically, our case corresponded closely to those observed by Meleney. In fact, all the reported cases tend to conform to certain unusual characteristics which will be briefly outlined.

The appearance of this type of wound infection may be quite delayed. In our own case the patient had been allowed to go home and the process did not appear for two weeks following operation. In Brewer's first case the appearance of the wound was satisfactory for seven days after operation, and did not become alarming for ten.[3] In his second case the wound infection was thought to be a very trivial one for a similar period. In the case reported by Cole and Heideman the appearance of the process was delayed even longer—eighteen days.[6]

The great majority of the patients who developed this complication had been operated on for suppurative appendicitis, but two cases in addition to

our own showed the process in thoracotomy incisions,[5,2], and in one case the lesion appeared in an incision made to drain a breast abscess.[14]

The rate of spread of the process has been relatively slow in all cases. Alexander estimated that the gangrenous margin in his case advanced approximately four millimetres per day.[1] In spite of this relatively slow advance, the lesion—unless radical surgery interferes—may extend to phenomenal limits. The enormous destruction of tissue in some cases has made it necessary for the patient to be hospitalized for many months.[14,1,16,5] In spite of this, eventual recovery is the rule. Only one case terminated fatally, and in that case acute nephritis was a contributing factor.[8]

The process remains, as a rule, quite superficial. In only one case did the deeper tissues become involved in the gangrenous process. In that case a large area of the abdominal musculature was destroyed, and Horsley was forced to resort to rather heroic measures to prevent evisceration.[10] Certain other features of this particular case make it somewhat doubtful if it really belongs in the group under consideration.

The lesion itself has a unique and characteristic appearance. It usually appears in the small wound made by a tension suture, and this is an extremely important observation which has been made repeatedly.[6,3,12] At first the infection may seem very trivial but as the area of involvement extends it becomes obvious that some unusual type of lesion is developing. The advancing margin is preceded by a wide bluish zone. The margin itself consists in a thin black rim which leaves behind a dirty, tenacious gray slough as it advances. As the slough separates, a clean granulating surface appears. Gentle pressure at the margin of the ulcer produces many small beads of pus which pop up from beneath the advancing edge. The lesion is extremely painful, far more so than the usual types of wound infection, and nitrous oxide may be required for the slightest handling. Conservative treatment has been uniformly useless in combating the process. The list of the various forms of local applications, radiation, *etc.*, that have been employed is a very long one.[12] It is a very justifiable tendency to wish to give conservative measures a fair trial, but in these cases radical measures must be resorted to promptly if long hospitalization, great scarring and prolonged pain are to be avoided.

Radical cure is effected by wide excision of the margins of the ulcerated area. This has usually been done with the actual cautery, but Meleney has demonstrated that the excision may be done with a scalpel, and carried well outside the zone of inflammation, without fear of starting the process anew. Inadequate excision will be followed by prompt recurrence, requiring a second excision. This happened in the case reported here, and others have had similar experiences.[16,12] The use of Thiersch grafts will shorten the stay in the hospital, and lessen scarring. However, small islands of epithelium usually appear unexpectedly in the granulating area, having survived the gangrenous process in deeply situated sweat-glands.

I believe that it is extremely important, as a prophylactic measure, to avoid

the use of tension sutures in drained McBurney incisions and in thoracotomy incisions. They serve no useful purpose in these cases, and subject the patient to the danger of this rare but alarming complication. They do this by diminishing the blood supply to the skin alongside the wound, and by furnishing an ideal opportunity for micro-aërophilic organisms to gain a foothold in the subcutaneous tissue. They may produce a "stab-culture" in the subcutaneous tissue, such as we often use in the bacteriological laboratory in culturing such organisms.

CONCLUSIONS

An additional case is reported of progressive post-operative gangrene of the skin, of a type which represents a clinical entity. The lesion is unusual. It has a very characteristic appearance, bacteriology, and clinical course.

The bacteriological findings in this case corresponded closely to those of Meleney. The process is produced by the symbiotic activity of a very small variety of streptococcus that prefers a low oxygen tension, and a staphylococcus.

Although developing in a thoracotomy incision, the streptococcus in this case (as in most reported cases) was thought to be of intestinal origin.

Conservative measures are of no help whatever in dealing with this type of infection. The treatment of choice is early wide excision, either with cautery or scalpel. Adequate excision results in prompt cure.

The use of tension sutures in drained incisions predisposes to the development of this alarming complication.

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TRANSACTIONS AMERICAN SURGICAL ASSOCIATION

MEETING HELD MAY 16, 17 AND 18, 1932; *Continued*

RADICAL OPERATIONS FOR CARCINOMA OF THE BREAST

A PRELIMINARY EXCISION OF THE TUMOR OR ABLATION OF THE BREAST

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The standards by means of which we may judge the success of an operation for carcinoma of the breast are the local cure of the disease, the avoidance of regional and distant metastases, and longevity. Only in so far as the factors concerned in the treatment are under a surgeon's control can he be held responsible for them.

By local cure is meant having the patient live without any sign of recurrence within the operative field, either in the scar, the skin, or the subcutaneous tissue. The appearance of a carcinoma at any time after a radical operation in the scar, the skin in the neighborhood of the scar, in the subcutaneous tissue of this same region, on the outer chest wall, or in the axilla, is classed as a recurrence.

Regional metastases are those secondary growths resulting from direct drainage of the operative field. They are probably all due to extensions along the lymphatic vessels. Supraclavicular and mediastinal lymph-node metastases belong to this group. Metastatic tumors situated in the chest wall probably are also metastatic in character and arise along the lymphatics accompanying the anterior perforating branches of the internal mammary artery. Perhaps secondary tumors in the opposite breast may be classed as regional metastases.

Distant metastases are those occurring in the osseous system and in internal organs at some distance from the operative field.

Longevity may depend on any of these factors but may be entirely independent of them and be influenced by the general condition of the patient or by intercurrent disease.

It has been customary to hold a surgeon responsible for local recurrences, for it has been felt and has been shown by experience that in properly performed radical operations they are rare. Metastases, on the other hand, both regional and distant, have been considered beyond a surgeon's control, and their prevention has apparently not received the amount of attention it deserves.

Various statistical reports dealing with the late results after operation for carcinoma of the breast make one feel that no real progress is being

made. We are at a standstill and a feeling of pessimism regarding the entire subject may be noted. Perhaps the best reports come from those clinics combining radical surgery with post-operative radiation. It is difficult to place the proper value on some of the published statistics. One does not always know whether patients were selected for operation or whether all patients in whom the tumor was removable are included. In the same way pathological classifications vary and border-line cases are at times included.

Ever since the radical operation was proposed by Halstead and Willy Meyer, attempts have been made to improve on the results first published, either by variations of the technical procedure or by the addition of pre- or post-operative radiation, or both. There have been and still are disputes concerning the necessity for the removal of a large area of skin, whether one or both pectoral muscles should be sacrificed, whether it is necessary to remove the fascia over the rectus muscle, *etc.* Much stress is laid by some authors on the type of incision, the amount of muscle and fascia excised, whether the skin is thoroughly undermined, thereby insuring the removal of a large quantity of subcutaneous fat, the importance of remaining outside the fascial sheath in the axillary dissection and never crossing the planes of possible cancer extension, and the need for removing the vessel sheath. These considerations are all of importance but none of them has advanced us materially. The results as far as can be judged are not much better than they originally were. The question regarding the value of pre- or post-operative radiation, or both, has not yet been settled. A study of the literature would lead one to believe that real advance along this line is possible. The danger is that radiation enthusiasts are often satisfied with an incomplete operation and depend on their treatment to destroy cancer cells which have been left behind. It would seem that a real radical operation followed by radiation over those areas along which cancer spread may be expected by the location of the tumor may help materially in improving our results.

Studying carcinoma recurrences or metastases from the standpoint of location may help us some in determining whether anything further can be done.

At the Lenox Hill Hospital we perform a very radical operation, we use meticulous care in the dissection and take ample time. The operation consists of:

(1) Removal of the breast with an adequate skin margin well beyond the tumor.

(2) Thorough undermining of the skin margins which insures extensive removal of the subcutaneous tissue with the breast, and aids in closing.

(3) Excision of the entire pectoralis major and minor.

(4) Removal of the entire axillary contents taking care to include the lymph-nodes in front of the scapula and those situated high in the axilla above the vessels.

(5) Thorough clean dissection of the chest wall.

(6) Skin graft when indicated.

The incision is varied somewhat depending on the position of the tumor.

With this technic we have found that

(1) Local recurrences are very rare.

(2) Axillary recurrences are almost unknown.

(3) Chest-wall tumors (intercostal, probably regional metastatic) are rare.

We have recognized that the operation as carried out is adequate to prevent recurrences. Any change in technic, therefore, would be simply aimed at improving the appearance of the scar. The functional results are perfect. Occasionally there is œdema of the arm, but very rarely of a disabling nature.

In spite of these favorable local results the death rate from late cancer of the breast is high at our hospital, as well as at other institutions. The patients die from metastases, not from recurrences. How and when are these metastases spread, and can anything be done to prevent their dissemination? The answer to this will determine whether there is going to be much improvement in our surgical results.

Any group study of patients with metastases following a radical breast operation will show a large percentage with intrathoracic involvement, either of the lungs, the pleura, or the mediastinal lymph-nodes. There are also intra-abdominal cases and a very large number of patients with metastases in the osseous system. Almost any organ may be involved. Frequently there is an isolated metastasis in a bone far removed from the field of operation. Carcinoma is usually believed to spread by way of the lymphatics, and many metastases can be explained on that theory. On the other hand, tumor emboli are frequently found in blood-vessels and it is conceivable that tumor cells enter the blood-stream directly in that way, rather than indirectly by way of the lymphatic circulation. Distant isolated metastases, especially those of the osseous system, are more easily explained on the theory of having been carried there by the blood-stream than by the lymphatics.

Depending on the location of the tumor within the breast, the lymphatic spread may be chiefly towards the axillary lymph-nodes, or along the lymph channels accompanying the penetrating blood-vessels of the anterior chest wall to the lymph-nodes of the mediastinum, or along any of the lymph channels crossing over to the opposite side or passing downward. The blood-stream spread may follow along these same general lines.

In trying to attain the best possible results it seems imperative to consider all these different paths and to take steps to prevent the dissemination of cancer cells beyond the accessible area.

We do this today by making an incision well beyond the tumor and in addition to the breast taking along a wide margin of skin and subcutaneous tissue, both pectoral muscles, the entire axillary contents with all fascial layers, and a meticulous dissection of the chest wall. Those who believe in the existence of lymphatic channels in the rectus sheath connecting with the liver also take away this sheath. As far as operative intervention is concerned, this is about all one can do. The only other accessible areas which

could be attacked surgically would be the supraclavicular region and the opposite breast. The comparative infrequency of supraclavicular involvement or of invasion of the opposite breast makes the removal of these organs as routine procedures inadvisable. The extensions along the perforating vessels into the mediastinum are inaccessible, or at least it is not justified to resect costal cartilages merely on the supposition that involved nodes may be situated along the internal mammary vessels.

The radical operation as practiced today contemplates the removal of all those tissues which may have been directly invaded by the tumor, as well as all the lymphatic vessels leading away from it, as far as they are accessible. Only in the direction toward the axilla does it include the system of lymph-nodes which drain the breast. Unfortunately, many tumors are situated within the breast at a place which drains into the mediastinum rather than towards the axilla. It is apparent, therefore, that the operation does not adequately guard against the spread along the perforating vessels, and it does not at all guard against spreading cancer cells by the blood-stream.

The question arises: Is it within our power to do anything to guard against the spread of cancer cells leading to metastases? To answer this we must consider the question of how and when cancer cells are spread. Taking an isolated bone metastasis, for instance, one may safely say that in the absence of local recurrences or regional metastases, it must have been carried there directly from the tumor either before or during the operation. Metastases which have developed or are in the process of developing before the patient comes under observation are evidently beyond a surgeon's control and he is not responsible for them. On the other hand, after the surgeon has seen the patient, he may be responsible for the spread of cancer cells by injudicious manipulation of the growth. Emphasizing this point rather strongly one may say that there is a possibility of improving our results by attention to this point. Rough handling of the breast and pressure on the tumor, or over the involved axillary lymph-nodes, may easily force cells into the lymphatic vessels or into the blood-stream. To avoid this it is very important to refrain from frequent and especially from rough handling of the breast and axillary contents by either the patient or the physician before operation.

I also want to call attention to the rough handling to which a breast is subjected during the operation. It is forcibly drawn over to the opposite side during the axillary dissection and there are any number of opportunities for cancer cells to become dislodged and carried into the circulation. To avoid this I have for several years changed my method of procedure, and made it a practice to either excise the tumor or do an ablation before proceeding with the radical operation. In all doubtful cases, and in clinically positive carcinoma cases in which the tumor is single and easily removable, I do an excision with a good margin of normal tissue, await the report on the frozen section, and if positive, proceed with the radical operation. The breast can be held by an assistant in such a way that no pressure is made on

the tumor. In all extensive carcinoma cases, and in those with multiple or ulcerating tumors, I do a rapid ablation without much handling and then immediately follow with the radical procedure.

Personal observation and a discussion of this subject with some of my colleagues have convinced me that patients in whom a preliminary excision of the tumor was done have not suffered as a result of this, but that on the contrary it seems to offer a way to reduce the number of patients developing metastases.

The only other way of controlling metastases seems to lie in radiation therapy. It is conceivable that pre-operative radiation may fix cancer cells by producing a fibrosis and thus make their spread less likely during operation. The combined treatment by surgery and radium implantations at the time of operation looks promising and deserves attention. Post-operative radiation over those areas most likely to become affected by drainage from the original cancer can do no harm and should be employed in selected cases, especially in those in whom the tumor was situated near the median line with probable extension into the mediastinal lymph-nodes.

The question of biopsy in breast cancer has long been a disputed one. Is it safe to do one or should the practice be condemned? To answer this one has to have a clear understanding of what is meant by a biopsy. If it is incision into the tumor with excision of a small piece for diagnosis, the practice is to be condemned as it opens up paths for spreading cancer cells. On the other hand, if it is complete excision of the tumor with a little surrounding normal tissue, it is a perfectly safe procedure, and is in line with the treatment of breast cancer advocated in this paper.

TRAUMATIC LESIONS OF ARTERIES: INDICATIONS FOR THERAPEUTIC LIGATION OF VEINS

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and

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Ligation of the accompanying vein in the course of ligation of large arteries was, before advocacy of this procedure by Makins, in 1917, almost never performed, except as a matter of dire necessity. It had been taught by surgeons of an earlier day that occlusion of the vein, in cases in which ligature of the large arteries of the extremities was required, would increase the risks of gangrene.

Although it is true that Oppel, in 1913, recommended ligation of the popliteal vein for treatment of senile gangrene of the foot, and that Sehrt, in 1916, urged its consideration on the grounds that ligation of the vein would prevent too rapid emptying of venous blood from the injured extremity, it was really the statistical work of Makins based on his experience with gunshot wounds in the South African war and in the World War that made generally accepted the principle of elective ligation of satellite veins. Makins, in comparing the results in a large series of cases in which only the artery of an extremity was ligated with a similar group in which both the arteries and veins were ligated, showed that simultaneous ligation of the accompanying vein actually reduced the incidence of gangrene. Prior to Makins' work, however, others had reported favorable results following this procedure, notably Zondek, Bernheim and Worth, Griebel, and Boeckel.

This measure, nevertheless, has been subject to some criticism. Halsted was not convinced that under ideal aseptic conditions gangrene was a frequent complication of ligation of large arteries, and stated that he was disinclined to tie off simultaneously the corresponding vein until evidence of ischæmia developed, because he felt that such a manœuvre would tend to delay the development of collateral circulation. Recently, Mulvihill, Harvey and Doroszka, in an experimental investigation of this problem, ligated the external iliac artery and vein of seven dogs. They concluded that ligation of the vein had no demonstrable effect in aiding or retarding development of collateral circulation, as shown by the curves of temperature obtained from the periphery of the extremity.

More recently, Montgomery, in a series of experiments on dogs, found that after ligation of the superficial femoral artery, ligation of its concomitant vein caused either no change or a slight decrease in the per minute volume flow of blood and a more marked decrease when the venous return was obstructed proximal to the site of arterial occlusion. He concluded that

ligation of the concomitant vein should be avoided in treatment of acute obstructions of the main arterial supply, unless the obstruction was in the popliteal artery, in which case the procedure is strongly supported by clinical data. He is of the opinion that it is wiser to await the appearance of impending gangrene before ligating the vein.

The clinical and experimental investigations of a substantial number of other workers, namely, Van Kend, Tuffier, Propping, Makins, LaRoque, Heitz, Brooks and Martin, Harvey and Ferris, McNealy, Holman and Edwards, Theis, and Pearse, provided much evidence to support the view that ligation of the corresponding vein is of definite value.

Although there is some controversy as to the manner in which this benefit is effected, we believe, with Brooks and Martin, that occlusion of the vein simultaneously with the artery results in greater intravascular pressure, although in a slightly smaller flow of blood, and that this increase in intravascular pressure forces blood into the distal capillary beds and serves to prevent complete collapse of the capillaries in the distal parts, and that this, in turn, results in more homogeneous distribution of the available blood. The more recent researches of Brooks and Johnson on distribution of the flow of peripheral blood in the dog are of particular interest. They employed a special apparatus for perfusion by which their material was kept at constant temperature, and the variation in temperature at different levels in the posterior extremity was taken as an index of the degree of distribution of the perfusion fluid. According to these experimenters, regulation of the flow of peripheral blood is extremely complex, depending on nervous, hormonal, and purely mechanical factors. They noted that experiments with the perfusion pump gave much the same results as experiments with living animals, as far as being able to influence distribution of blood is concerned. They stated: "The blood flow was unequally distributed, and this distribution could not be appreciably changed by any method used." Nevertheless, from their observations on the effect of increasing venous pressure, they concluded: "Usually increasing venous pressure did appreciably change the distribution of the blood flow in the perfusion experiments. In some instances it seemed possible, so to speak, to open a portion of the vascular bed for circulation by increasing venous pressure."

From our clinical experience, and that of others, we are of the opinion that simultaneous ligation of the concomitant vein is of definite value in selected cases. That this procedure may be inadvisable under certain conditions was first recognized by Brooks, in 1923. In a later article he stated: "It would seem, therefore, as if the remote effects of therapeutic venous obstruction must be taken into consideration. In other words, ligation of a vein might be the means of averting gangrene, but the cause of subsequent chronic venous stasis. The clinical experience available is not sufficient for drawing definite conclusions."

Reference to the literature reveals no very adequate clinical criterion to aid the surgeon in determining in a given case whether the vein should be occluded. Even

Makins was uncertain, for in a letter to Brooks in 1922, he stated: "I have seen some swollen extremities and varicose veins amongst the war pensioners, but in all cases I have had the opportunity of examining, the injury to the vessels was accompanied either by very extensive wounds with loss of substance, or fracture of the femur or pelvis. I have not been able to regard these cases as a fair test, and no uncomplicated case of ligature of artery and vein with unsatisfactory after-consequences has come under my notice. Still, I think the question of the ultimate condition of the limb must be considered undecided." We have reviewed the pertinent clinical literature which has appeared on this subject since the publication of Makins' work, and in no instance have we been able to find a clear-cut definition of either the indications for, or contra-indications to, this procedure. Propping, for example, recommended ligation of the vein in cases in which gangrene may be expected. LaRoque wrote: "There is genuine reason for believing that vein ligation favors the development of collateral vessels, and through retention of blood volume and pressure aids enlargement of vessels already present." McNealy, writing on elective ligation of veins in surgery of blood-vessels, stated: "Simultaneous vein ligation must be so selected that it will serve only to restore circulatory equilibrium and must not result in too great a damming back of blood, lest ill effects of passive congestion outweigh the beneficial effects of increased capillary pressure. Here again Bier has pointed out that venous blood does become a source of trouble when the passive congestion exists over a long period and the venous blood becomes surcharged with tissue poisons. Knowing the good effects which may be expected to follow vein ligation, one must also bear in mind that there is a certain lethal limit in the tidal flow of blood to an extremity or tissue."

Holman and Edwards, in 1927, advocated ligation of the vein proximal to the site of ligation of the artery. In the same year, Holman stated: "The circumstances demanding the ligation of the vein proximal to arterial ligation would presumably be dependent upon the extent to which collateral circulation had already developed as the result of the lesion which necessitated the ligation. Proximal ligation of the vein would be applicable in all cases which entailed an acute shutting off of the arterial supply, as in traumatic injury to vessels. If for any reason a collateral circulation had already developed, its application would probably be less imperative and perhaps accompanied by a certain degree of danger of swelling in the limb."

Theis gave his views on elective ligation of the concomitant vein in the following words: "With sudden occlusion of a large artery, as in embolism or injury to the vessel, the immediate improvement in the collateral bed due to ligation of the concomitant vein is needed to maintain the vitality of the limb. When a certain amount of collateral vessels have had an opportunity to develop, as in threatened spontaneous gangrene, surgical procedures on the main vessels of the extremities should be limited to the artery alone."

A great deal of generalizing but little information of practical value is found. As a general summary of the problem, the following statement by Brooks is significant: "Simultaneous ligation of the vein is not to be considered the preferable procedure in all arterial ligations. It is to be applied only in those instances in which without ligation of the vein gangrene would be expected. In these instances, the probably immediate beneficial effects in preventing gangrene must be balanced with the possible remote ill effects of chronic venous stasis."

There is, of course, abundant clinical evidence to support the admonition of Brooks against indiscriminate ligation of the concomitant vein in all cases of obstruction of the artery. In the first place, statistics gathered from practice both in war and in civil life show that when only the main artery of an extremity is obstructed, in only a relatively small percentage of cases does gangrene ensue, requiring amputation of the extremity. This per-

centage is variable, apparently depending on many factors, chief of which are the following: The site of obstruction of the artery; the extent of associated trauma to the contiguous tissues; the presence or absence of infection; the mode of onset of arterial obstruction, that is, whether sudden or progressive, and the employment of or lack of preliminary measures, in cases of contemplated surgical ligation, to stimulate development of collateral circulation. In the second place, not infrequently the venous stasis induced by simultaneous ligation of the concomitant vein results in protracted œdema and swelling of the extremity, in some instances persisting as permanent disability.

The desirability of avoiding this latter complication is obvious, and therefore, before any step is undertaken to obstruct the principal venous channel, careful consideration should always be given, not only to the need of such a procedure as an aid in maintaining circulation in the extremity, but also to the risk of development of troublesome venous stasis. On the other hand, there are ample clinical and experimental data to indicate that in some cases of arterial obstruction, ligation of the concomitant vein may be a valuable procedure in reducing the incidence of gangrene, and furthermore, there is sufficient clinical evidence to show that, in selected cases of arterial obstruction, ligation of the satellite vein apparently has been the means of maintaining adequate circulation to the extremity without, at the same time, producing any of the evil effects of venous stasis. In one of our cases of obstructive aneurism of the common femoral artery, with beginning gangrene of the toes, ligation of the femoral vein restored adequate circulation to the extremity without producing swelling and œdema.

It is evident, therefore, that therapeutic ligation of the concomitant vein is indicated in certain cases of arterial obstruction, whereas it is contra-indicated in others. Maintenance of adequate supply of blood to the tissues distal to the point of obstruction of the artery is obviously dependent on efficiency of the collateral circulation. As is known from anatomical dissection, there is considerable variation in the development of the collateral arterial tree in different subjects and in the same subjects in different regions of the body. From the clinical standpoint, the variation in the incidence of gangrene of the extremity following ligation of the artery under almost identical conditions also indicates variability in the efficiency of collateral circulation of different patients. It is obvious, then, that in arterial obstruction surgical treatment should vary according to adequacy of the collateral circulation. When the collateral circulation is inadequate, ligation of the accompanying vein, as a means of aiding circulation to the extremity, is definitely indicated. However, when the collateral circulation is adequate it is obvious that venous occlusion is not only not indicated, but is definitely contra-indicated on account of the risk of producing imbalance of the circulation.

Clinical criteria exist by which the surgeon can at the time of the operation determine whether simultaneous ligation of the vein should be done. Since 1918, one of us (Pemberton) at the suggestion of C. H. Mayo, has

been employing a simple and apparently accurate clinical test; previously, in 1912, this test (Fig. 1) had also been described in the literature by Henle and his assistant Stoltz, and again independently by Coenen. The test depends on observation, during the operation of the exposed arterial segments, both proximal and distal to the lesion. If a retrograde flow of blood is obtained from the opened end of the distal arterial segment, while the proximal portion is being compressed with a clamp, it is taken as an indication of adequate collateral circulation. The Quénu-Muret sign, described in 1910, is similar, and depends on the detection of bleeding from any portion of the peripheral arterial tree after puncture or incision, when the main trunk of the limb is being compressed. Naturally, such a procedure is objectionable. Matas reviewed the merits of the various methods which had been

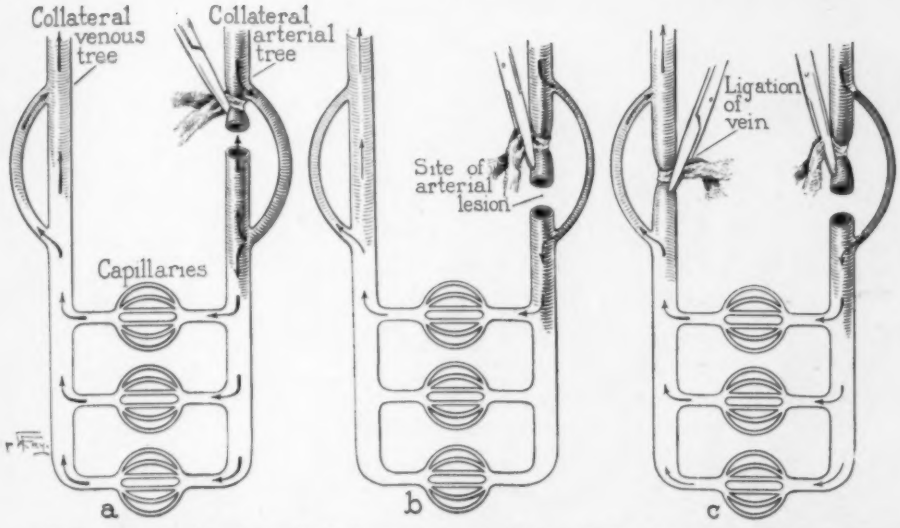

FIG. 1.—Mechanism of the Henle-Coenen test: (*a*) Retrograde flow from, or pulsations in artery on distal side of lesion with proximal side occluded, denotes positive Henle-Coenen sign and indicates adequate collateral circulation. (*b*) No retrograde flow from, or no pulsation in artery on distal side of lesion, with proximal side occluded, denotes negative Henle-Coenen sign and indicates inadequate collateral circulation. Blood fails to reach distal capillary bed. (*c*) Occlusion of main accompanying vein induces more equal distribution of blood throughout capillary bed.

proposed for testing collateral circulation, including the Henle-Coenen sign, which he regarded as "fallacious and liable to erroneous interpretation." He admitted, however, that it is of value in dealing with emergencies concerned with wounded, bleeding arteries, when used in conjunction with the other two signs of the Von Frisch test; namely, a normal or approximately normal coloration of the peripheral parts when the proximal side of the injured vessel is compressed, and the appearance of venous stasis on the peripheral side of the temporarily occluded main vein, the artery proximal to the lesion, of course, being compressed meanwhile.

As regards the Henle-Coenen test alone, there is considerable clinical evidence to show that peripheral gangrene is a rare complication when a positive Henle-Coenen sign has been obtained. Table I is an analysis of fifteen of

TABLE I

Data Concerning Fifteen Cases in Which the Henle-Coenen Sign Was Recorded

Case	Age (Yrs.), Sex	Indications for Ligation	Circulatory Efficiency before Operation	Date of Operation	Type of Operation	Henle-Coenen Sign	Results	Comment
1	30 P.	Accidental injury to right external iliac artery	Apparently normal to routine physical examination	12-15-17	Ligation of right external iliac artery	Positive	Dismissed 1-10-28; excellent condition	Arterial injury during course of external Alexander operation
2	57 M.	Spontaneous aneurism of left popliteal artery; syphilis	Adequate	1- 5-20	Left popliteal artery ligated, and Matas obliterative endo-aneurismorrhaphy	Positive	Dismissed 2-27-20; complete recovery; circulation adequate	
3	39 M.	Traumatic aneurism of left thigh, arteriovenous varix (?)	Poor; ulceration left leg; venous stasis; no pulsations dorsalis pedis and posterior tibial arteries	12- 1-19	Left common femoral artery ligated and arteriovenous fistula (?) ligated	Positive		
		Returned 10-28-25; ulceration of left leg, diagnosed arteriovenous aneurism left femoral vessels	Same	11-11-25	Excision of arteriovenous aneurism from left femoral vessels			
		Returned 2-4-26 with mass in left side behind peritoneum	Same	2- 8-26	Removal of segment of aneurismal sac from region of left external iliac artery		Dismissed 4-28-26; persistence of pain, swelling and ulceration in left leg	2-1-30 patient still complained of swelling, pain and ulceration of left leg
4	40 M.	Accidental injury to left external iliac artery	Apparently adequate on routinely made physical examination	6-30-21	Exploration of tumor of left ureter; ligation of left external iliac artery	Positive	Given Röntgen treatment and dismissed 7-26-21; circulation in extremity satisfactory	3-21-29 patient in good health
5	46 F.	Spontaneous aneurism of left popliteal artery; Wassermann test negative	Adequate, although pulsation of dorsalis pedis absent	11- 9-23	Obliterative endo-aneurismorrhaphy and ligation of popliteal artery and vein	Positive (?)	Dismissed 1-3-26; pain and swelling in leg and left foot drop; very slight retrograde bleeding	3-26-26 same complaint of pain and swelling in leg
6	33 M.	Traumatic aneurism of right femoral artery	Adequate, but considerable swelling in extremity	8-14-25	Femoral artery ligated; femoral vein probably also ligated	Positive	Dismissed 9-21-25; complete recovery	4-18-27 patient able to work
7	40 M.	Left femoral aneurism, ruptured (traumatic?)	Adequate	10- 1-25	Left superficial femoral artery ligated · obliterative endo-aneurismorrhaphy	Positive	Dismissed 1-29-26; complete recovery	

8	44 M.	Bilateral popliteal aneurism accompanying Buerger's disease	Matas test indicated adequate circulation	12- 4-25	Obliterative; endo-aneurismorrhaphy of left popliteal artery	Negative	Circulation adequate although vessels of foot could not be palpated	10-30 no recurrence of aneurism: still complained of symptoms of thrombo-angiitis obliterans
				1- 6-26	Same operation right popliteal artery			No arterial symptoms but recurring superficial-phlebitis
		Spontaneous left femoral aneurism developed during convalescence	Adequate by Matas test; intermittent compression employed	2- 5-26	Obliterative aneurismorrhaphy of left femoral aneurism	Positive	3-1-26 dismissed in good condition	
9	21 M.	Traumatic aneurism (?) left femoral artery	Adequate; intermittent compression used	2-20-32	Ligation of femoral artery	Positive	Dismissed 5-11-32; completely recovered	
10	12 M.	Aneurism of right superficial femoral artery, traumatic	Adequate	7- 4-28	Obliterative endo-aneurismorrhaphy of right superficial femoral artery	Positive	Dismissed 7-20-28; completely recovered	
11	63 M.	Spontaneous aneurism right common femoral artery; Wassermann test negative	Inadequate; ischæmia with threatening gangrene	2-11-31	Obliterative endo-aneurismorrhaphy; ligation of femoral artery, elective ligation of femoral vein	Negative	Dismissed 7-20-31; completely recovered	Circulation improved greatly with ligation of concomitant vein
12	8 M.	Stab-wound in right thigh; severe hæmorrhage followed later by ischæmia; beginning gangrene	Poor; extremity swollen, painful, tender, cool; no peripheral pulsations	6-23-31	Right deep femoral artery ligated	Positive	Dismissed 7-27-31; complete recovery	
13	47 F.	Spontaneous aneurism right brachial artery; Wassermann test negative	Adequate; intermittent compression used	8-19-31	Proximal and distal ligation and obliterative endo-aneurismorrhaphy of right brachial artery; elective ligation of brachial vein	Positive (?)	Dismissed 8-31-31; circulation good; radial pulse absent; no swelling	No pulsations of distal artery at operation, but sac filled with proximal artery clamped
14	40 M.	Left subclavian hematoma, traumatic	Inadequate; swelling, pain, cold, cyanosis	1- 6-32	Ligation of subclavian artery third portion; elective ligation of vein	Negative	At first ischæmia with gangrene of tips of fingers: swelling; pain; ulceration; patient still in hospital at time of writing; circulation improving gradually	Vascular lesion was associated with injury to brachial plexus; at time of writing seemed that probably he would require amputation because of total loss of function
15	60 F.	Embolism and thrombosis of left femoral and popliteal arteries	Inadequate	11-24-27	Embolectomy and partial removal of thrombus; ligation of left femoral artery; elective ligation of left popliteal vein	Negative	Died 11-28-27; at necropsy myocardial degeneration with infarction, hypertension, and gangrene of left leg and foot	Cases of embolus should not be compared with the other vascular lesions in this table because of unknown extent of thrombotic occlusion

our cases in which the Henle-Coenen sign was recorded. We are fully in agreement with Matas on the necessity of determining the efficiency of the collateral circulation before operation, and we believe that the circulation should be tested by the several methods which have gained acceptance by those experienced in surgery of the vascular system. Nevertheless, it is our conviction that the Henle-Coenen sign affords a valuable and practical index to the need for ligation of the concomitant vein, and we believe that this point may be adequately determined by noting at operation the condition of that segment of the artery immediately distal to the site of the lesion. In other words, if any pulsation is perceptible, or if there is arterial backflow when the vessel has been opened surgically, even though slight, one is safe in assuming that collateral circulation is probably sufficiently well developed to render simultaneous ligation of the accompanying vein unnecessary. It is obvious, as we have pointed out before, that the evil effects of chronic venous stasis are avoided as long as no great imbalance exists between the amount of venous blood and the amount of arterial blood. On the other hand, in cases in which there is no pulsation in the distal segment of the artery, or if there is no backward flow of blood in the event the vessel has been surgically opened, we believe that the satellite vein should be ligated, in order that more nearly equal distribution of the available blood may be induced. (Fig. 1.) Before drawing final conclusions, the blood-pressure in the brachial artery should be known, for obviously lowered systemic blood-pressure would affect local conditions materially. It is readily conceivable that in cases in which the systemic blood-pressure has been greatly depressed, as by hæmorrhage, shock, prolonged anæsthesia, or operation, there may not be sufficient flow of blood through an otherwise adequate collateral arterial tree to produce retrograde flow from the opening of the distal artery. Under these circumstances a negative Henle-Coenen sign would not necessarily indicate that collateral circulation would be subsequently deficient and in absence of preliminary tests of the efficiency of the collateral circulation, it would be impossible to determine the need of occlusion of the vein. In such instances, partial occlusion of the vein should be considered as a substitute for complete, permanent occlusion. This could be effected by narrowing the lumen of the vessels with a strip of fascia obtained from some nearby muscle sheath. We have not, so far, had an opportunity of trying this modification of partial occlusion, but we see no reason why, in border-line cases, it should not prove of value.

We consider a positive Henle-Coenen sign, therefore, as an absolute indication that collateral circulation is efficient. On the other hand, a doubtful positive, or even a negative Henle-Coenen sign, may not be an absolute indication of collateral circulatory inefficiency. There are several factors which may produce a border-line state with regard to the Henle-Coenen sign, and the decision to ligate the accompanying vein must take into consideration such influences as depression of systemic blood-pressure, peripheral vasomotor disturbances such as temporary vasospasm, and possible coëxistence of

chronic obliterative arterial disease. Even in instances in which a negative sign, or a very weak positive sign is obtained, it is conceivable that adequate collateral circulation may yet develop within the so-called critical time, and thus the onset of gangrene will be prevented. In this connection, the experimental work of Mulvihill and Harvey on peripheral thermic changes after arterial ligation and ganglionectomy, and also after section of the spinal cord or posterior roots and ganglionectomy, is of special interest. These investigators noted a fall in temperature of the foot after ligation of the corresponding iliac artery, and that the temperature returned gradually to its previous level after lapse of about thirteen hours. When the tributary sympathetic ganglia were removed simultaneously this fall in temperature did not occur, and when performance of sympathetic ganglionectomy was delayed until the temperature of the foot had dropped to that of the room, its return to normal was greatly accelerated. Transection of the spinal cord, or of the posterior roots below the level of the first lumbar vertebra, was without appreciable effect. In the opinion of Mulvihill and Harvey, their data suggest that reëstablishment of former conditions by collateral circulation is a vasomotor phenomenon. It is possible, however, that the sudden anæmia incident to acute arterial occlusion may set up widespread peripheral vasoconstriction affecting the capillary bed extensively, and causing the temporary drop in temperature. Sympathetic ganglionectomy prevents or ameliorates this condition by removing vasopressor influences.

In contemplated operations for ligature of the artery, efficiency of the collateral circulation should be accurately determined by Matas' test, provided the proposed site of obstruction is situated in a part of the body where the artery is accessible to methods of intermittent compression. In instances in which the tests indicate collateral circulation to be deficient, great improvement may be obtained in almost all cases after a period of systematic intermittent compression of the artery according to the method of Matas. When such preliminary tests give evidence of efficient collateral circulation, we have never seen serious ischæmia ensue after occlusion of the artery. In operations for recent traumatism of the artery, or for aneurisms inaccessible to compression, it is highly desirable that the efficiency of the collateral circulation be determined at the time of the operation by elicitation of the Henle-Coenen sign, before deciding on the method of surgical treatment.

The records of The Mayo Clinic, from 1915 to 1931, show that there were sixty-five cases in which ligation or other obliterating type of operation was performed on large arteries and veins for relief of aneurisms, arteriovenous varices, and vascular tumors of various sorts. In this group there were twenty-nine cases in which the lesion was situated in the head or neck, or in which ligation of the large arteries of the head and neck was required. In the remaining thirty-six cases, there were lesions of the arterial trunks in or leading to the extremities. Of this group of thirty-six patients, the youngest was eight years of age and the oldest sixty-three years of age. The

average age of the patients was 35.5 years. Thirty-one of them were males and five females.

There were thirty-eight lesions in these thirty-six cases, as follows: traumatic aneurisms, nine; spontaneous aneurisms, ten (in association with only one of which was syphilis evident); arteriovenous aneurisms, twelve; and accidental wounding of large arteries, five. Furthermore, ligation because of hæmorrhage after embolectomy was performed in one case, and ligation to facilitate excision of neoplasm in one case. The sites of the lesions were as follows (two lesions in the same vessel in two cases); external iliac arteries, four cases; common iliac artery, one case; popliteal artery, five cases; axillary artery, one case; internal iliac artery, three cases; subclavian artery, three cases; brachial artery, four cases; common femoral artery, three cases; superficial femoral artery, nine cases, and deep femoral artery, three cases.

Both artery and vein were involved as follows: popliteal vessels, four cases; axillary vessels, two cases; common femoral vessels, one case; radial vessels, one case; peroneal vessels, one case, and superficial femoral vessels, two cases. Both right and left sides were involved in one case. The right side, therefore, was involved in eighteen cases and the left in nineteen cases (thirty-six patients in all). The artery alone was ligated in eighteen cases, whereas in twelve cases it was deemed necessary, for various reasons, to ligate the accompanying vein. In the other six cases the fistula of an arteriovenous varix was occluded.

In the group of eighteen cases in which a large artery alone required ligation there was complete recovery of function in ten cases, and considerable improvement in three cases. In one case there was associated bilateral thrombo-angiitis obliterans which was unrelieved, and in one an amputation through the upper part of the forearm was required because of a painful arteriovenous varix in the palm. In two cases there was persistent swelling and ulceration of the extremity. In one case there was secondary hæmorrhage and shock with beginning gangrene and the patient died. In the group of twelve cases in which both artery and vein were ligated, there were four in which ligation of the concomitant vein was performed as an elective procedure in an attempt to improve an already inadequate circulation, and in this group there was complete improvement in one and marked improvement in another. One of these patients died from auricular thrombosis and gangrene of the foot, and in one case painful, swollen exremities with ulcerations developed. In the remaining eight cases of this group of twelve in which ligation of both artery and vein was performed, the results were as follows: complete recovery in five cases and marked improvement in one case. Two patients died in hospital of bronchopneumonia, one had gangrene of the extremity, and the other, marked œdema of the limb on the side on which both vessels had been ligated.

In the group of eleven cases in which arteriovenous aneurisms were found (in six of which the fistula was obliterated, and in five, other operations

were performed) the results were good in eight cases. One patient required amputation because of a painful arteriovenous varix of the hand, and one had persistent swelling, pain and ulceration in the extremity. There was one death in this group from infection and gangrene.

In the entire group of thirty-six cases there were five deaths in hospital, two from bronchopneumonia and gangrene, one from gangrene and infection in an amputation stump, one from auricular thrombosis and gangrene of the foot, and one from hæmorrhage and shock with gangrene. In three of these cases, both main vessels were occluded by ligature at operation, and in one case secondary hæmorrhage, infection and gangrene followed ligation for a popliteal arteriovenous communication. In the remaining case, the right subclavian artery was ligated because of hæmorrhage eight days after an operation for bilateral cervical rib. The patient died the same day, and at necropsy thrombosis of the right brachial artery and gangrene of the fingers were noted.

The following case record is reported in detail because it demonstrates the value of ligation of the vein in the presence of existing ischæmia with threatening gangrene.

A man, aged sixty-three years, was admitted to The Mayo Clinic February 6, 1931, complaining of infection in the right foot, of six weeks' duration, and "rheumatism" of the thigh, and of the muscles of the right calf, intermittently for the last ten years. Disability included aching and tenderness in the right inguinal region, induced by walking and relieved by application of dry heat. Five years before, he had noticed a swelling in the right popliteal region, which gradually had increased. One week before he came to the clinic the pain became much worse, and at the same time the third and fifth toes of the right foot became discolored. There was no increased swelling in the extremity.

Physical examination gave essentially negative results except that a firm, irregular mass was found occupying the right femoral triangle. The mass apparently was fixed to the deeper structures. There was no fluctuation and no pulsation, and the overlying skin was not involved. Pulsation of the external iliac artery could be felt above the mass, but there was no pulsation of the femoral artery immediately below it. A similar mass about five centimetres in diameter occupied the popliteal region. The right foot exhibited marked cyanosis on dependency, and a considerable degree of blanching on elevation, and was perceptibly cooler than the left. Palpation of the peripheral vessels on the two sides of the body disclosed normal pulsations in all vessels on the left side, but pulsations in the femoral, popliteal, dorsalis pedis, and posterior tibial arteries of the right side were totally absent. There were trophic changes in several of the toes of the right foot, but in the small toe, there was definite gangrene of the first stage. The urine was normal; the value for hæmoglobin, and the erythrocyte count were normal, but leucocytes numbered 15,200 in each cubic millimetre of blood. Röntgenological examination of the pelvis gave evidence of a foreign body, possibly a shot just over the right acetabulum; no lesions of the vessels of the extremities could be demonstrated. The Wassermann reaction of the blood was negative. A diagnosis of occlusion of the arteries of the right leg, with gangrene of the first stage of the right fifth toe, was made. The nature of the masses in the groin and in the popliteal space could not be determined, but the diagnosis seemed to lie between a malignant neoplasm on the one hand, and an aneurism on the other. February 2, 1931, the femoral triangle was explored. An aneurism of the right femoral artery, beginning just below Poupart's ligament, and

producing a mass about nine by six by six centimetres, was found. The sac was fusiform, and was entirely filled with old clotted blood; there were no pulsations, either expansile or transmitted. In attempting to define the limits of the sac, the femoral vein was accidentally perforated to such extent that ligature seemed indicated. The aneurism was then opened and the clot evacuated. There was no fresh bleeding until forceps were introduced into the proximal opening, and then a free flow of arterial blood occurred. The distal part of the artery could not be found, and there was no bleeding from the opened end of the distal portion of the aneurism. The aneurism, therefore, was obliterated by endo-aneurismorrhaphy. The most interesting feature of the case was that on the second day after operation there was noticeable improvement in circulation. One week after operation, the foot was warm and presented a normal, pink color. The regions of beginning gangrene seemed to be clearing up. There was no obvious œdema from ligation of the vein. Two weeks later, the condition of the foot was remarkably improved and although there was still much scaling over the area of the chemical burn, the crusting lesions of the first toe were rapidly disappearing. Fig. 2 shows the appearance of the limb at the time of the patient's dismissal from the clinic March 10, 1931, after an uneventful convalescence; the area of gangrene was entirely healed.

FIG. 2.—Appearance of leg at time of dismissal of patient (Case XI) whose right femoral artery was the site of aneurism with occlusion by a clot, and whose right femoral vein was ligated.

We heard from this patient July 20, 1931; he reported that he was in good general health, and that his foot was doing well. (Fig. 2.)

CONCLUSIONS.—Ligation of the main venous channel at the time of ligation of its companion artery in cases of inadequate collateral circulation is a valuable procedure. It is definitely contra-indicated in cases in which collateral circulation is adequate, because of the prolonged circulatory imbalance likely to be induced. In cases in which collateral circulation is inefficient, ligation of the concomitant vein provides more homogeneous distribution of the available blood and increases the chances of survival of the limb beyond the so-called critical time. Efficiency of the collateral circulation should be determined as accurately as possible before operation, and confirmed at operation by employment of methods such as we have described (Henle-Coenen sign). When the Henle-Coenen sign is positive, ligation of the accompanying vein is contra-indi-

cated, and when this sign is negative, ligation of the main venous channel is advocated.

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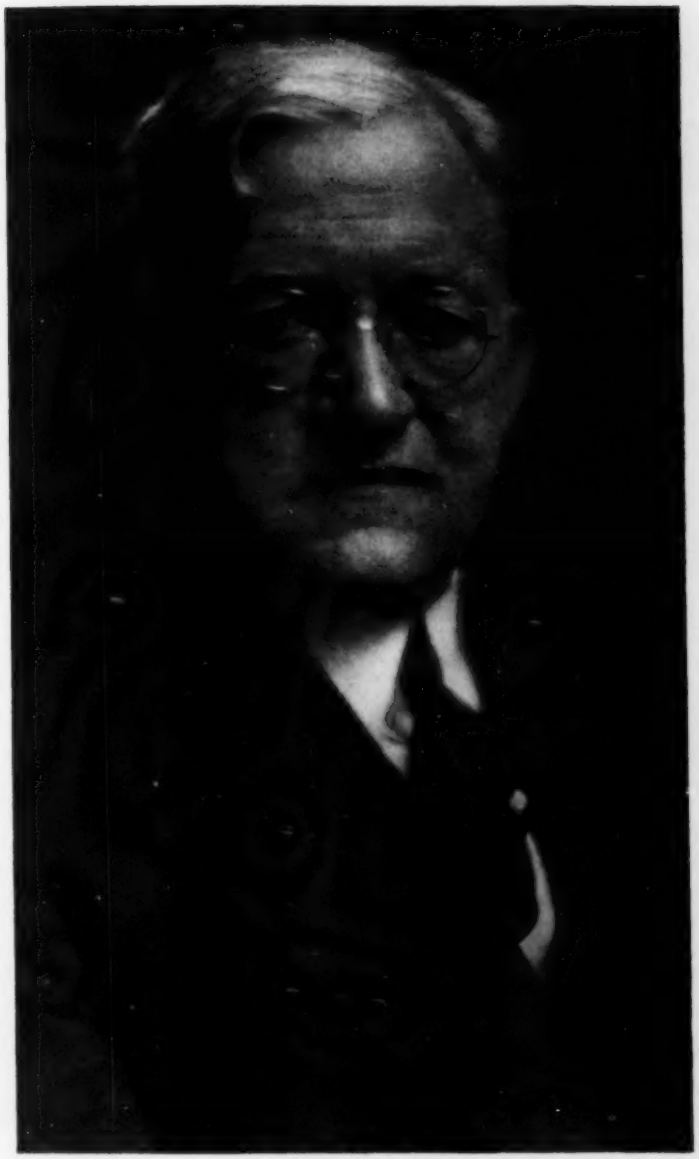
FRANK L. HUPP, M.D.

1929



FRANK L. HUPP, M.D.

DR. FRANK LEMOYNE HUPP was elected a member of the American Surgical Association in 1919. He received the degree of M.D. in 1889 from

the College of Physicians and Surgeons of New York, and for two years thereafter was a member of the house staff of the Presbyterian Hospital in the same city.

Frank LeMoyne Hupp was born at Wheeling, West Virginia, July 8, 1865. For years he had looked forward to practising surgery in Wheeling, W. Va., and his entire professional career was pursued in that city. He quickly became attached to the staffs of several hospitals and was soon recognized as a leading surgeon, not only in Wheeling, but in the adjacent Ohio Valley as well. Although never a prolific writer, his contributions to surgical literature, including papers read by him before this Association, were of a clinical character, sound, carefully prepared and invariably of a high order of merit.

On December 26, 1929, while engaged in the daily routine of surgical work, and without previous warning, he sustained an apoplectic seizure from which he died without regaining consciousness.

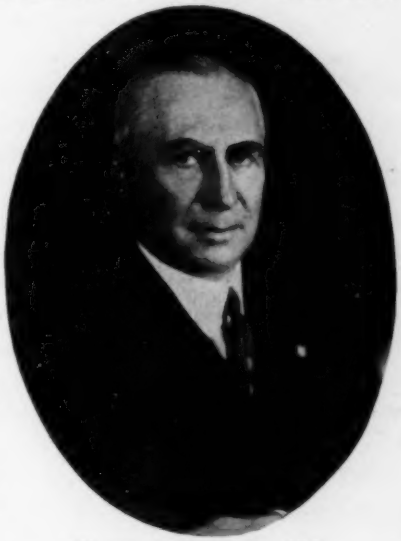
Doctor Hupp possessed many unusual attributes. Ambitious, energetic, and endowed with a strong constitution, he devoted himself to the practise of his profession with the greatest enthusiasm; and yet he never neglected the duties of a citizen and spared no effort to develop and improve the welfare of the community in which he lived. Generally respected and admired, his sterling character and his attractive personality endeared him to many friends and commanded the confidence of all who knew him.

ELLSWORTH ELLIOTT.

WALTER AIKMAN SHERWOOD, M.D.

1875–1931

Dr. Walter A. Sherwood, of Brooklyn, N. Y., died November 21, 1931, in the fifty-sixth year of his age. He was born in Jersey City, New Jersey, December 25, 1875. His primary education was at the Hasbrouck Institute of that City and at Rutgers College, New Brunswick, which institution in later years conferred upon him the honorary degree of Doctor of Science. After a course of two years at Rutgers, during which he specialized in the classics and in biology, he matriculated at the College of Physicians and Surgeons of Columbia University from which school he received his degree of M.D. in June, 1896.



Walter A. Sherwood, M.D.

The course of his education was well planned to prepare for the practice of medicine. While an undergraduate he served in surgical positions for brief periods at the Roosevelt Hospital, Bellevue Hospital and the Vanderbilt Clinic of New York and finally after graduation had a service of two years as an interne in the Methodist Episcopal Hospital of Brooklyn. At the close of this interneship he was appointed the Assistant to the First Surgical Service (Dr. Lewis S. Pilcher) of the hospital. In November, 1899, he entered upon his work as a general practitioner in the city of Brooklyn. In the course of the years he was a member of the Kings County Medical Society, Brooklyn Surgical Society, Brooklyn Pathological Society, The Society of Associated Physicians of Long Island, The New York Surgical Society and the American Surgical Association. He was elected a Fellow of the last Association in 1927. With this foundation and these associations, added to his native qualities, he developed a professional career of marked success characterized by broad accomplishments, unusual sagacity, thorough devotion to the highest principles of his profession and admirable citizenship. Repeated visits to the clinics of Europe added to his information and skill. After a period of six years as an assistant surgeon in the Methodist Episcopal Hospital he was made an attending surgeon and served that institution as such from 1908 to 1916. In 1914 he was made also an associate surgeon in the Brooklyn Hospital in which institution his main work was done during the latter years of his life, having been made a full attending surgeon

in 1916, with advancement to the Directorship of Surgery in 1925, a position which he held to the time of his death.

In his entire career he exemplified a deliberate purpose to secure the highest attainment in the profession which he had chosen. In addition to the head of the department of surgery in a great hospital in the city of his residence, he held such honorary positions as Consulting Surgeon to the Methodist Episcopal Hospital and the Eastern Long Island Hospital. He presented many papers before surgical societies. He made frequent journeys to foreign lands for study and recreation.

He entered the service of the U. S. Army in 1918 and the following year he received the rank of Lieutenant-Colonel and was made the Chief Surgeon of the U. S. A. General Hospital No. 1, at Williamsbridge, in the vicinity of New York City, which position he held to the close of the war.

As a surgeon he was fully founded in all the requirements of its science and art. More than this to his scientific acquirements he brought a quality of kindness and courtesy which gave him a most attractive character. To his fine professional abilities he added high standards of ethical conduct so that his career was an inspiration to those that had the privilege of his acquaintance, and the memories of his life remain as a highly cherished treasure to his colleagues and friends.

LEWIS S. PILCHER.

EDITORIAL ADDRESS

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